

# TUpH™ Retractable pH/ORP Sensors



## ESSENTIAL INSTRUCTIONS

### READ THIS PAGE BEFORE PROCEEDING!

Rosemount Analytical designs, manufactures, and tests its products to meet many national and international standards. Because these instruments are sophisticated technical products, you must properly install, use, and maintain them to ensure they continue to operate within their normal specifications. The following instructions must be adhered to and integrated into your safety program when installing, using, and maintaining Rosemount Analytical products. Failure to follow the proper instructions may cause any one of the following situations to occur: Loss of life; personal injury; property damage; damage to this instrument; and warranty invalidation.

- Read all instructions prior to installing, operating, and servicing the product. If this Instruction Manual is not the correct manual, telephone 1-800-654-7768 and the requested manual will be provided. Save this Instruction Manual for future reference.
- If you do not understand any of the instructions, contact your Rosemount representative for clarification.
- Follow all warnings, cautions, and instructions marked on and supplied with the product.
- Inform and educate your personnel in the proper installation, operation, and maintenance of the product.
- Install your equipment as specified in the Installation Instructions of the appropriate Instruction Manual and per applicable local and national codes. Connect all products to the proper electrical and pressure sources.
- To ensure proper performance, use qualified personnel to install, operate, update, program, and maintain the product.
- When replacement parts are required, ensure that qualified people use replacement parts specified by Rosemount. Unauthorized parts and procedures can affect the product's performance and place the safe operation of your process at risk. Look alike substitutions may result in fire, electrical hazards, or improper operation.
- Ensure that all equipment doors are closed and protective covers are in place, except while maintenance is being performed by qualified persons, to prevent electrical shock and personal injury.

## DANGER

### HAZARDOUS AREA INSTALLATION

Installations near flammable liquids or in hazardous area locations must be carefully evaluated by qualified on site safety personnel. This sensor is not Intrinsically Safe or Explosion Proof.

To secure and maintain an intrinsically safe installation, the certified safety barrier, transmitter, and sensor combination must be used. The installation system must comply with the governing approval agency (FM, CSA or BASEEFA/CENELEC) hazardous area classification requirements. Consult your analyzer/transmitter instruction manual for details.

Proper installation, operation and servicing of this sensor in a Hazardous Area Installation is entirely the responsibility of the user.

## WARNING

### RETRACTABLE SENSORS

Retractable sensors must not be inserted nor retracted when process pressures are in excess of 64 psig (542kPa) for option 21 or 35 psig (343 kPa) for option 25.

## CAUTION

### SENSOR/PROCESS APPLICATION COMPATIBILITY

The wetted sensor materials may not be compatible with process composition and operating conditions. Application compatibility is entirely the responsibility of the user.

## ATEX DIRECTIVE

### Special Conditions for safe use

1. All pH/ORP sensors have a plastic enclosure which must only be cleaned with a damp cloth to avoid the danger due to a build up of an electrostatic charge.
2. All pH/ORP sensor Models are intended to be in contact with the process fluid and may not meet the 500V r.m.s. a.c. test to earth. This must be taken into consideration at installation.

## About This Document

This manual contains instructions for installation and operation of the Model 396R & 396RVP TU<sub>p</sub>H Retractable pH/ORP Sensors. The following list provides notes concerning all revisions of this document.

<u>Rev. Level</u>	<u>Date</u>	<u>Notes</u>
A	1/96-1/01	This is the initial release of the product manual. The manual has been reformatted to reflect the Emerson documentation style and updated to reflect any changes in the product offering.
B	7/02	Revised multiple drawings.
C	8/02	Added drawing #40105549, rev. D.
D	4/03	Revised drawing #40396R21/22 on page 18.
E	8/03	Added Silcore information.
F	9/04	Updated ordering info and added/revised wiring drawings.
G	1/05	Delete obsolete options.
H	1/07	Miscellaneous revisions.
I	11/10	Removed mention of patents and updated dnv logo.
J	2/11	Added ATEX directive and updated caution boxes per ANSI standard.

# MODEL 396R AND 396RVP RETRACTABLE pH/ORP SENSORS

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## SECTION 1.0 DESCRIPTION AND SPECIFICATIONS

### 1.1 FEATURES AND APPLICATIONS

The **Model 396R and 396RVP Sensors** are specifically designed for improved life in harsh, dirty applications where a separate sample stream is difficult to provide and greater insertion depths are required. Model 396R is designed for use with a 1-1/4 in. or 1-1/2 in. ball valve for hot tap installation. The Model 396R is constructed of molded polypropylene housed in a titanium tube with EPDM seals to provide maximum chemical resistance<sup>2,3</sup>.

Model 396R also features a titanium solution ground for advanced sensor diagnostics when used with the Models 1055, Xmt-P, 54e, 81, 3081, or 5081 pH/ORP Analyzer/Transmitter. Advanced sensor diagnostics provide preventative maintenance by notifying the operator for replacement and cleaning of an aged or fouled sensor for continuous optimum performance.

The sensor also features a shrouded tip for protection from breakage while allowing process to flow by the glass electrode for accurate and reliable pH measurement.

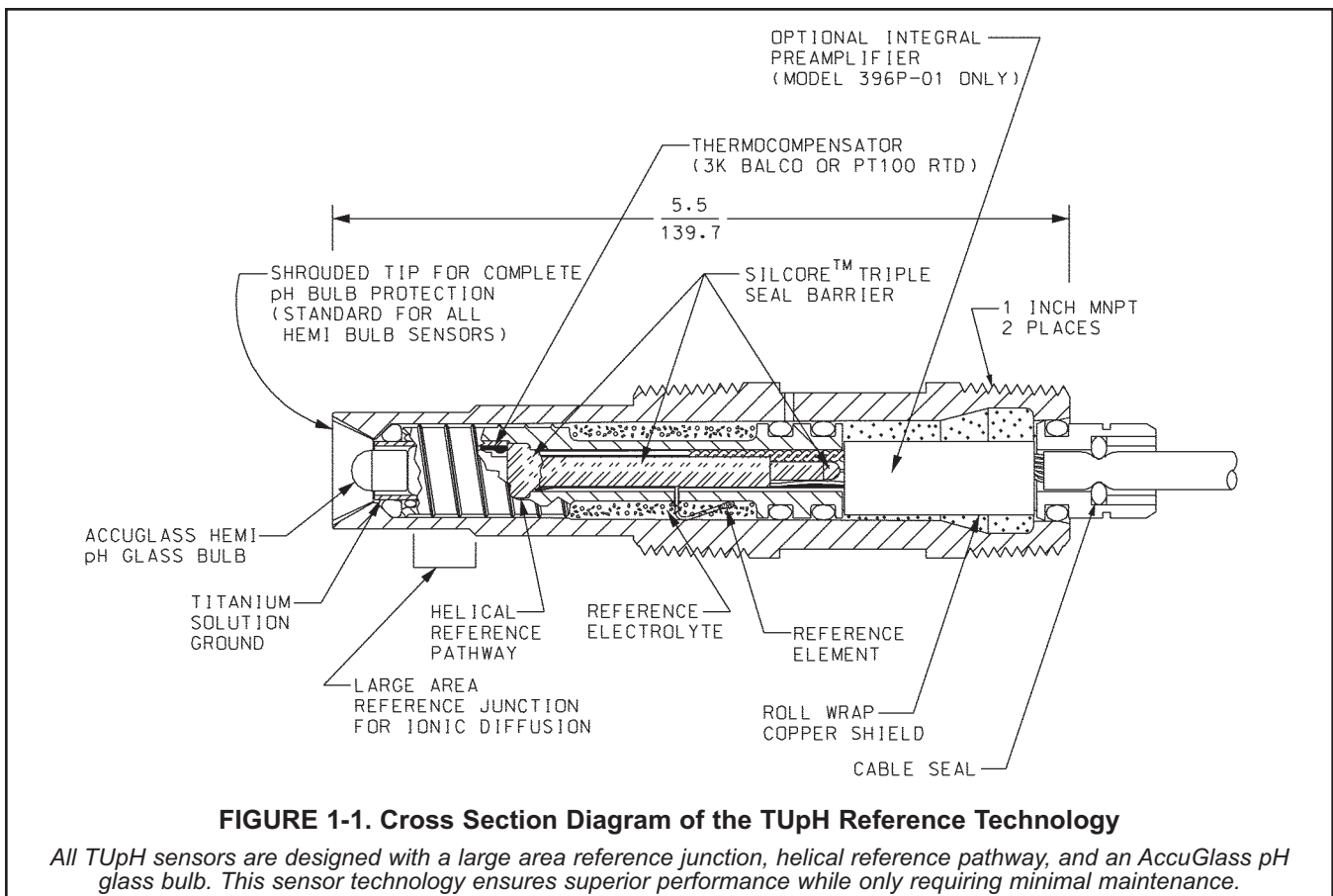
The Model 396R is available without an integral preamplifier only and 15 ft or 9.5 in. of integral high quality 9 conductor cable. The preamplifier must be housed in a remote location or in a J-Box kit for attachment at the rear, cable end of the sensor (order separately) or integral to the Analyzer/

Transmitter. The Model 396R is compatible with all Rosemount Analytical and various other manufacturers instruments.

**The entire line of TUpH model sensors now incorporate the new SILCORE<sup>1</sup> technology contaminant barrier.** This triple-seal barrier prevents moisture and material impurities from migrating to the pH sensor's reference electrode's metal lead wire. By preventing these contaminants from compromising the integrity of the pH measurement, sensor life is increased, especially at higher temperatures where increased migrations occur. In addition, the SILCORE technology provides added protection against sensor failure due to vibrations and shock by transferring damaging energy away from the glass-to-metal seal.

**Model 396RVP:** Rosemount Analytical has recently released Model 396RVP. This model has identical performance and physical specifications to the Model 396R (see Section 1.2) with the following exception: the Model 396RVP has a Variopol (VP) connector on the back end of the sensor in place of a cable.

<sup>1</sup> Silcore is a trademark of Rosemount Analytical.



**1.2 PERFORMANCE AND PHYSICAL SPECIFICATIONS****MODEL 396R****Measured Range:**

ORP: -1500 to 1500mV

pH: 0 to 14

Percent Linearity Over pH Range:

	Hemi Bulb	Flat Bulb
0-2 pH	94%	93%
2-12 pH	99%	98%
12-13 pH	97%	95%
13-14 pH	92%	—

**Wetted Materials:** Polypropylene, EPDM, titanium, glass, (platinum: ORP only)**Process Connections:** 1-1/2 or 1-1/4 in. with ball valve, 1 in. without ball valve**Cable:** Integral 15 ft or 9.5 in. 9 conductor cable except option 60 (9.5 in. coaxial cable with BNC) Recommended Interconnect (PN 9200273)**Maximum Process Pressure and Temperature:**

Hemi bulb: 150 psig (1136 kPa abs) at 212°F (100°C)

Flat bulb: 100 psig (790 kPa abs) at 212°F (100°C)

**Maximum Pressure at Retraction or Insertion:**

Code 21: 64 psig (542 kPa abs)

Code 25: 35 psig (343 kPa abs)

**Minimum Conductivity:** 100 µS/cm**Weight/Shipping Weight:**

Sensor:

Code 21: 2.0 lb/3.0 lb (.9 kg/1.40 kg)

Code 25: 3.0 lb/4.0 lb (1.40 kg/1.80 kg)

Ball Valve:

PN 23240-00; 5 lb/7 lb (2.25 kg /3.20 kg)

PN 23634-00 8 lb/10 lb (3.65 kg/4.55 kg)

J-Box: 3 lb/4 lb (1.40 kg/1.80 kg)

**MODEL 396RVP****Measured Range:**

ORP: -1500 to 1500mV

pH: 0 to 14

**Available pH glass types:** GPLR hemi bulb or flat bulb**Wetted Materials:** Polypropylene, EPDM, titanium, glass, (platinum: ORP only)**Process Connections:** none, use 1-inch process connector or ball valve kit (1-1/2 inch or 1-1/4 inch)**Temperature Range:** 0 to 100C (32 to 212F)**Pressure Range (hemi bulb):** 100-1136 kPa abs (0-150 psig)**Pressure Range (flat bulb):** 100-790 kPa abs (0-100 psig)**Maximum Pressure at Retraction or Insertion:**

Code 21: 64 psig (542 kPa abs)

Code 25: 35 psig (343 kPa abs)

**Minimum Conductivity:** 75 µS/cm, nominal**Preamplifier options:** remote**Weight/Shipping Weight:**

Sensor: Code 21: 2.0 lb/ 3.0 lb (.9 kg/1.40 kg)

Code 25: 3.0 lb/4.0 lb (1.40 kg/1.80 kg)

Ball Valve: PN 23240-00; 5 lb/7 lb (2.25 kg /3.20 kg)

### 1.3 ORDERING INFORMATION

The **Model 396R Sensor** is housed in a titanium tube, with a polypropylene reference junction and titanium solution ground for use with a ball valve (order separately) for hot tap applications. The sensor is available with either a hemi or flat glass pH electrode and features a shrouded glass/platinum electrode and PT100 or 3K temperature compensation. The 396R is available with 9.5 in. or 15 ft of integral cable. The 396R sensor is not available with a preamp. Junction box kits with preamps must be ordered separately if the analyzer/transmitter does not have an integral preamp within 15 ft. of the probe. Process connector and ball valve assemblies must also be ordered separately.

<b>MODEL 396R TUpH RETRACTABLE pH SENSOR</b>	
CODE	MEASURING ELECTRODE TYPE (Required Selection)
10	GPLR hemi glass, General Purpose Low Resistivity
12	ORP
13	GPLR flat glass, General Purpose Low Resistivity
CODE	SENSOR LENGTH
21	21 in. Titanium Tube
25	36 in. Titanium Tube
CODE	ANALYZER/TC COMPATIBILITY (Required Selection)
50	For Models 1181 (3K TC)
54	For Models 1054B, 1055, 2081,54e, 81, 3081, 4081, 5081, Xmt, SCL-(P/Q), (PT 100 RTD)
CODE	OPTIONAL OPTIONS
60	9.5 in. Cable with BNC (for use with Model 1181, 1054 series, 2054, 2081 Sensor Head J-Boxes)
61	9.5 in. Cable no BNC (Not Valid w/Option 50) (for use with Model 54e, 1055, 81, 3081, 4081, 5081, Xmt Sensor Head J-Boxes)
<b>396R - 10 - 21 - 54</b>	
<b>EXAMPLE</b>	

The **Model 396RVP ball valve retractable sensor** features a gel-filled electrolyte solution with the large area, coating resistant TUpH polypropylene reference junction and a standard hemi or optional flat glass bulb. Model 396RVP is housed in a Titanium sensor tube and can be mounted directly into the process using a 1 in. MNPT threaded process connector and a ball valve assembly kit (both ordered separately). It is offered with the water-tight Variopol sensor-to-cable connector and uses the mating connector cable (ordered separately). Also available is a choice of temperature element, 3 K Balco or Pt 100 RTD. A remote preamplifier found in the analyzer/transmitter or in a junction box (ordered separately) must be used with this sensor for a reliable signal transmission.

<b>MODEL 396RVP TUpH RETRACTABLE pH/ORP SENSOR</b>	
CODE	MEASURING ELECTRODE TYPE (Required Selection)
10	Hemi bulb, General Purpose Low Resistivity
12	ORP
13	Flat, GPLR glass
CODE	SENSOR LENGTH (Required Selection)
21	21 in. Titanium Tube
25	36 in. Titanium Tube
CODE	ANALYZER/TC COMPATIBILITY (Required Selection)
50	For Models 1181 (3K TC)
54	For Models 1054B, 1055, 2081,54e, 81, 3081, 4081, 5081, Xmt, SCL-(P/Q), (Pt 100 RTD)
<b>396RVP - 10 - 21 - 54</b>	
<b>EXAMPLE</b>	

TABLE 1-1. COMMONLY USED ACCESSORIES FOR MODEL 396R

<i>For first time installations, Rosemount Analytical recommends using the following guide</i>	
<b>1. Retractable Mounting</b>	
<b>A. Choose one (required for all first time installations):</b>	
PN 23166-00, 1 in. x 1 in. NPT process connector, 316 SST	
PN 23166-01, 1 in. x 1 in. NPT process connector, Titanium	
<b>B. Choose one:</b>	
PN 23240-00, 1-1/2 in. ball valve assembly, 316 SST	
PN 23765-00, 1-1/4 in. ball valve assembly, 316 SST	
<b>2. Junction Boxes (Optional; Choose either Sensor Head or Remote)</b>	
<b>A. Sensor Head Junction Boxes (used with options -60 or -61 sensor) - Choose one:</b>	
PN 23709-00; includes preamplifier for Models 54e, 81, 3081, 4081, 5081, Xmt, 1055	
PN 23708-01; includes preamplifier for Models 1054 series, 2054, 2081	
PN 23707-00; includes preamplifier for Model 1181	
<b>B. Remote Junction Boxes (used with standard 15 ft. cable length sensor) - Choose one:</b>	
PN 23555-00; includes preamplifier for Models 54e, 81, 3081, 4081, 5081, Xmt, 1055	
PN 23309-03; includes preamplifier for Model 1181	
PN 23309-04; includes preamplifier for Models 1054 series, 2054, 2081	
<b>3. BNC Adapter - Choose one:</b>	
PN 9120516, BNC Adapter for use with remote junction boxes PN's 23309-03 and 23309-04	
Order option -60 (standard with BNC connector) for PN 23707-00 or 23708-01 sensor head junction boxes	
<b>4. Extension Cables - Choose one:</b>	
PN 23646-01, 11 conductor, shielded, prepped	
PN 9200273, 11 conductor, shielded, unprepped	

TABLE 1-2. OTHER ACCESSORIES FOR MODEL 396R

PART	DESCRIPTION
22698-00	Preamplifier plug-in for J-box, for Model 1003,
22698-02	Preamplifier plug-in for J-box, for Models 1181/1050
22698-03	Preamplifier plug-in for J-box, for Models 1054A/B, 2054, 2081
23550-00	Remote Junction box with extension board
9550167	O-ring, 2-214, EPDM for process connector
9210012	Buffer solution, 4.01 pH, 16 oz
9210013	Buffer solution, 6.86 pH, 16 oz
9210014	Buffer solution, 9.18 pH, 16 oz
22743-01	Pt100 preamp for Model 1181
22744-01	3K Preamp for Model 1181
23557-00	Preamplifier for junction box for Models 1055, 54e, 81, 3081, 4081, 5081, Xmt



**TABLE 1-3. COMMONLY USED ACCESSORIES FOR MODEL 396RVP**

FOR FIRST TIME 396RVP AND 398RVP INSTALLATIONS, ROSEMOUNT ANALYTICAL RECOMMENDS USING THE FOLLOWING GUIDE:

<p><b>1. Variopool Cable (required for all first time installations)</b></p> <p>Choose one: PN 23645-06, 15 ft cable with mating VP connector, prepped with BNC on analyzer end PN 23645-07, 15 ft cable with mating VP connector, prepped without BNC on analyzer end*</p> <p><b>2. Retractable Mounting</b></p> <p>1A. Choose one (required for all first time installations, except as noted): PN 23166-00 1 in. x 1 in. NPT process connector, 316 SST PN 23166-01 1 in. x 1 in. NPT process connector, Titanium</p> <p>Choose one (optional process connector o-rings): PN 9550220, Kalrez<sup>®</sup> o-ring, 2-214 PN 9550099, Viton<sup>®</sup> o-ring, 2-214</p> <p>1B. Choose one: PN 23240-00 1-1/2 in. ball valve assembly, 316 SST PN 23765-00 1-1/4 in. ball valve assembly, 316 SST (process connector not needed)</p> <p><b>3. Remote Junction Boxes (Optional)</b></p> <p>Choose one: PN 23555-00 includes preamplifier for Models 54e, 81, 3081, 4081, 1055, 5081, Xmt PN 23309-03 and PN 22698-02 plug-in preamplifier for Model 1181 Analyzer PN 23309-04 and PN 22698-03 plug-in preamplifier for Models 1054 series and 2081 Analyzers</p> <p><b>4. Extension cables</b></p> <p>Choose one: PN 23646-01, 11 conductor, shielded, prepped PN 9200273, 11 conductor, shielded, unprepped</p>
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\* Used for connections to Models 1181, 2081, 54e, 81, 3081, 4081, 5081, Xmt, 1055, and remote junction box PN 23555-00.

<sup>2</sup> kalrez and Viton are registered trademarks of DuPont Performance Elastomers.**TABLE 1-4. OTHER ACCESSORIES FOR MODEL 396RVP**

PART	DESCRIPTION
22698-00	Preamplifier plug-in for junction box, for Model 1003,
22698-02	Preamplifier plug-in for junction box, for Models 1181, 1050
22698-03	Preamplifier plug-in for junction box, for Models 1054B, 2081
22743-01	Pt100 preamplifier for Model 1181
22744-01	3K Preamplifier for Model 1181
23557-00	Preamplifier for junction box for Models 54e, 81, 3081, 4081, 5081, Xmt, 1055
33046-00	Ferrule, 1 in., split 316SS
9310096	Nut, swage, 1 in. 316SST
9210012	Buffer solution, 4.01 pH, 16 oz
9210013	Buffer solution, 6.86 pH, 16 oz
9210014	Buffer solution, 9.18 pH, 16oz
R508-80Z	ORP solution, 460 mv $\pm$ 10 at 20°C
9550167	EPDM O-ring for Process Connector (PN 23166-00 or 23166-01)
12707-00	Jet Spray Cleaner

## SECTION 2.0 INSTALLATION

**2.1 UNPACKING AND INSPECTION.** Inspect the outside of the carton for any damage. If damage is detected, contact the carrier immediately. Inspect the instrument and hardware. Make sure all items in the packing list are present and in good condition. Notify the factory if any part is missing.

### NOTE

If the sensor is to be stored, the protective boot should be filled with either KCl electrolyte solution or pH 4.0 buffer solution and replaced on sensor tip until ready to use.

### NOTE

Save the original packing cartons and materials as most carriers require proof of damage due to mishandling, etc. Also, if it is necessary to return the instrument to the factory, you must pack the instrument in the same manner as it was received. Refer to Section 8.0 for instructions.

### WARNING

Glass electrode must be wetted at all times (in storage and in line) to maximize sensor life.

**2.2 MECHANICAL INSTALLATION.** The Model 396R Sensor may be installed through a weldolet or in a pipe tee or "Y", as shown in Figure 2-1, when used with a ball valve. Insert the end of the sensor to a depth sufficient to ensure that the glass bulb is continuously wetted by the process fluid. The Model 396R can also be inserted directly into the process without the use of a ball valve for applications not requiring continuous operation during sensor maintenance.

### CAUTION

Allow sufficient room for safe retraction and insertion of the sensor. Personnel should have room for stable footing while performing removal or insertion of the sensor.

The sensor must be mounted within 10-90 degrees of the horizontal with the tip pointed downward, thus keeping air bubbles off of the pH sensitive glass bulb. Bubbles settled on the glass bulb disrupt the electrical continuity between the pH sensitive glass and the silver/silver chloride measuring element.

If the retraction version is to be installed without a ball valve follow the installation procedure for insertion service (Section 2.2.2). Perform the following steps for sensor installation through a ball valve:

#### 2.2.1 INSTALLATION THROUGH BALL VALVE.

1. Carefully remove the liquid filled rubber boot which protects the glass electrode and keeps the liquid junction wet during shipping and storage. Discard the liquid and boot. Make sure the lubricated O-ring is in place in the groove inside the male connector on the sensor body.

### CAUTION

Buffer solution, in the protective boot, may cause skin or eye irritation.

2. With the male connector on the sensor's body, insert the sensor into the ball valve until it gently touches the closed valve. The molded electrode guard will protect the glass bulb from breakage.
3. Thread the male connector body tightly into the ball valve assembly. **DO NOT** tighten the hex nut on the male connector body; doing so would not allow the sensor to be inserted through the ball valve.
4. Pull back hard on the sensor assembly, as if trying to remove the sensor, to be certain that the sensor cannot come free of the ball valve assembly. The built-in retraction stop will butt against the shoulder of the male connector if properly installed.

### CAUTION

The sensor must be captured by the valve assembly and the male connector so that it cannot be blown free by process pressure if mishandled during insertion or retraction.

5. After confirming that the sensor assembly is properly secured by the valve assembly, the valve may be opened and the sensor positioned into the process at the desired depth and orientation.

6. While holding the sensor in position, tighten the hex nut of the male connector to firmly secure the sensor in place. When the hex nut is tightened, the Teflon ferrule inside the compression fitting clamps the sensor tube.

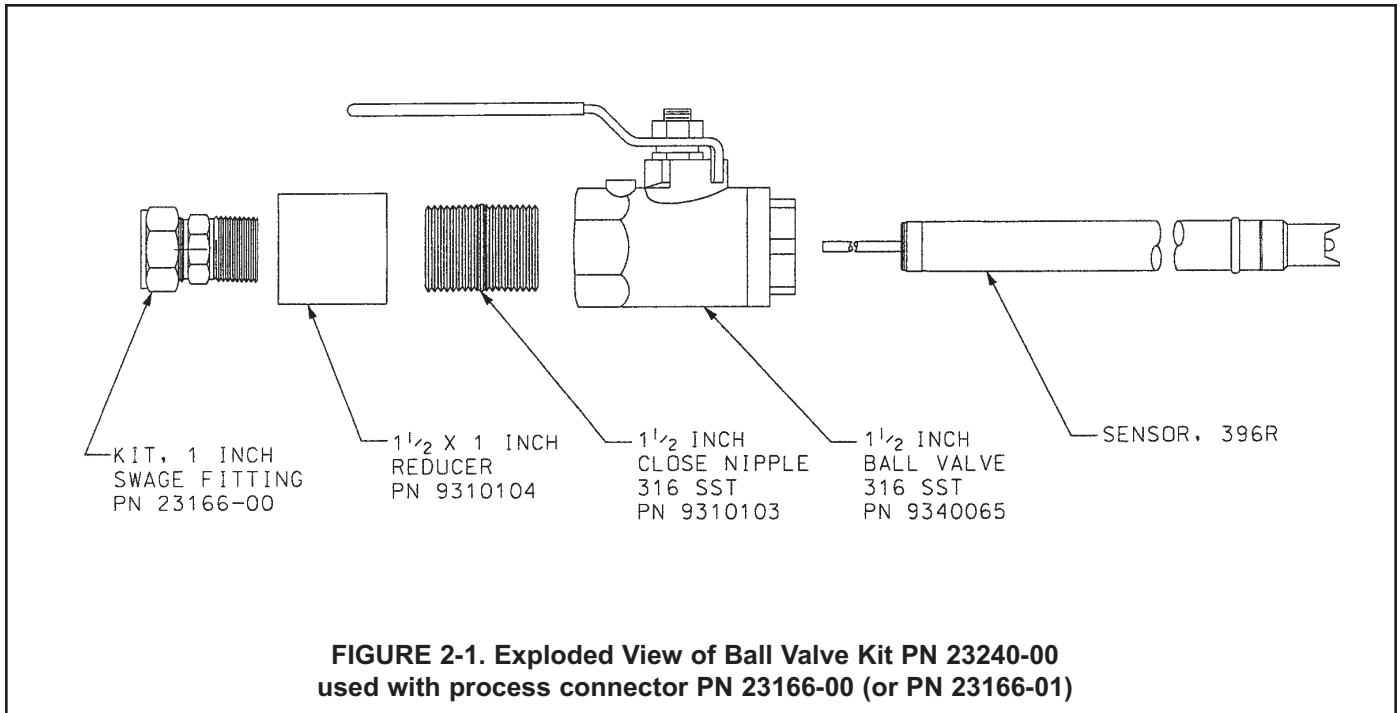
**2.2.2 INSTALLATION WITHOUT A BALL VALVE.** The Model 396R Sensor may be installed through a weldolet or pipe tee or "Y" when used with a process connector (PN 23166-00 or 23166-01). The sensor should be installed within 80° of vertical, with the electrode facing down.

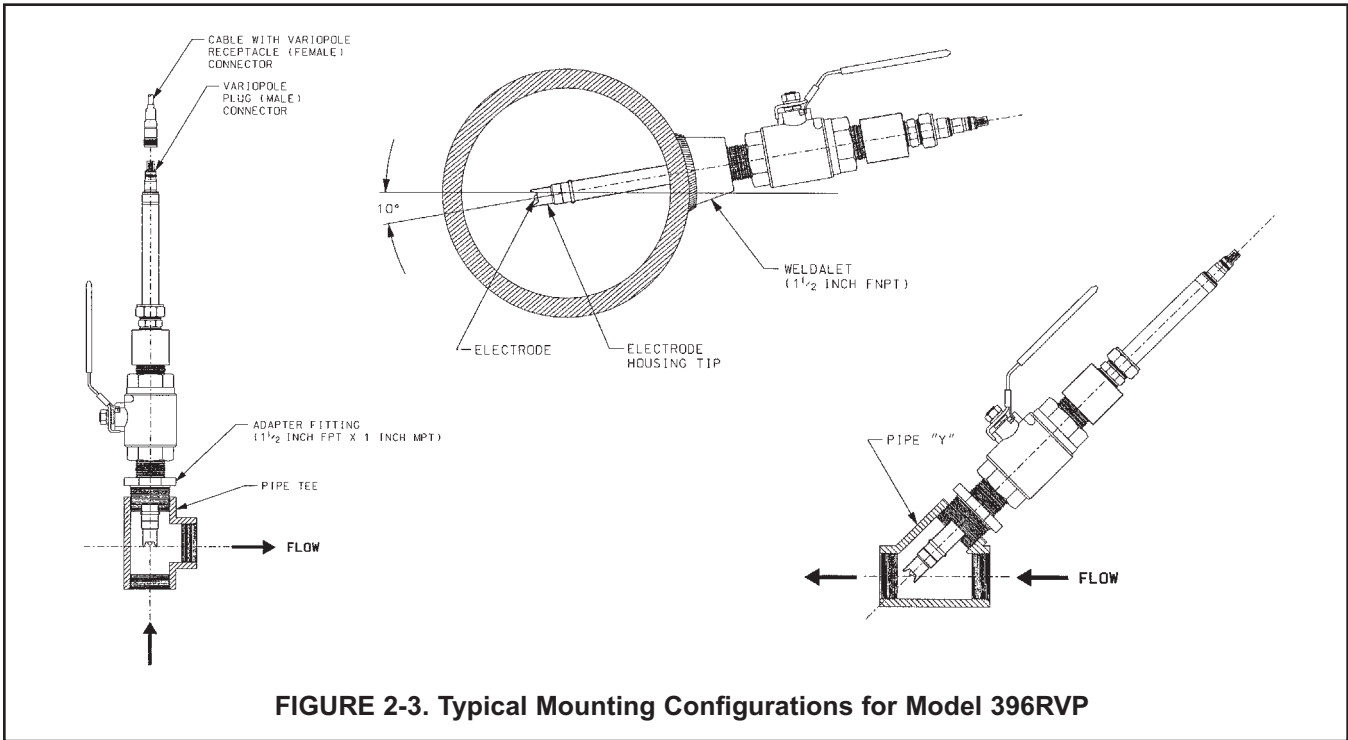
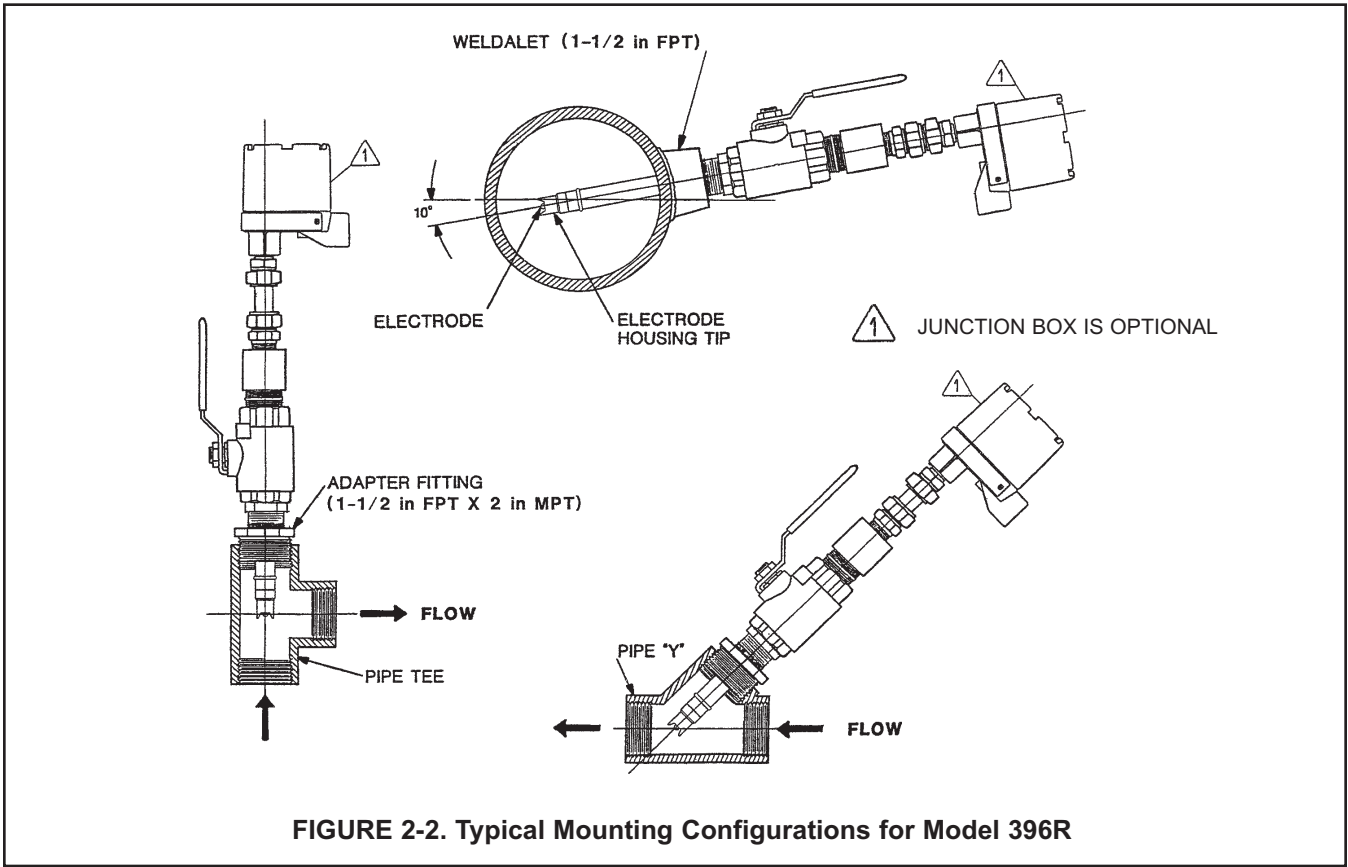
**CAUTION**

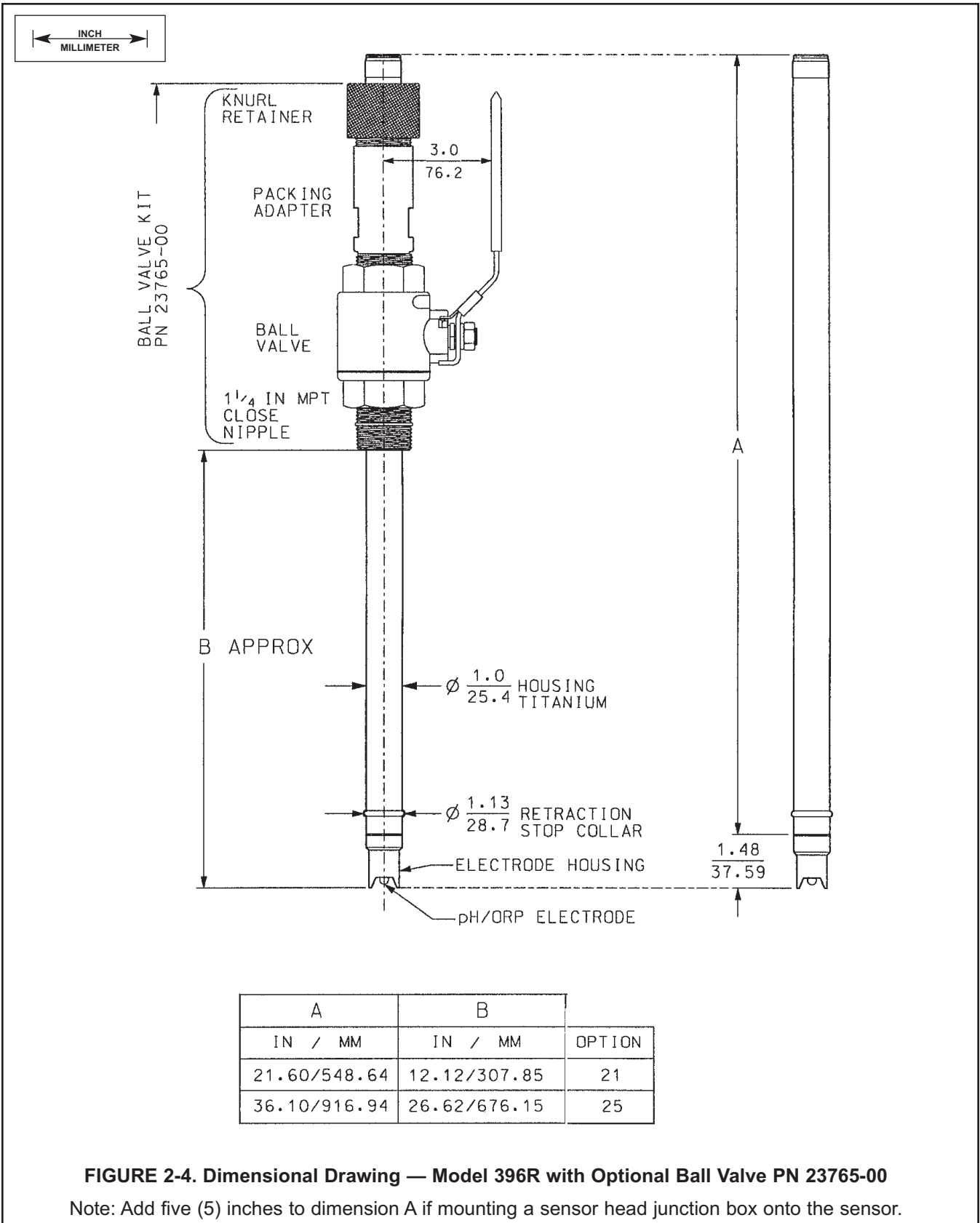
Over tightening the hex nut may damage the ferrule.

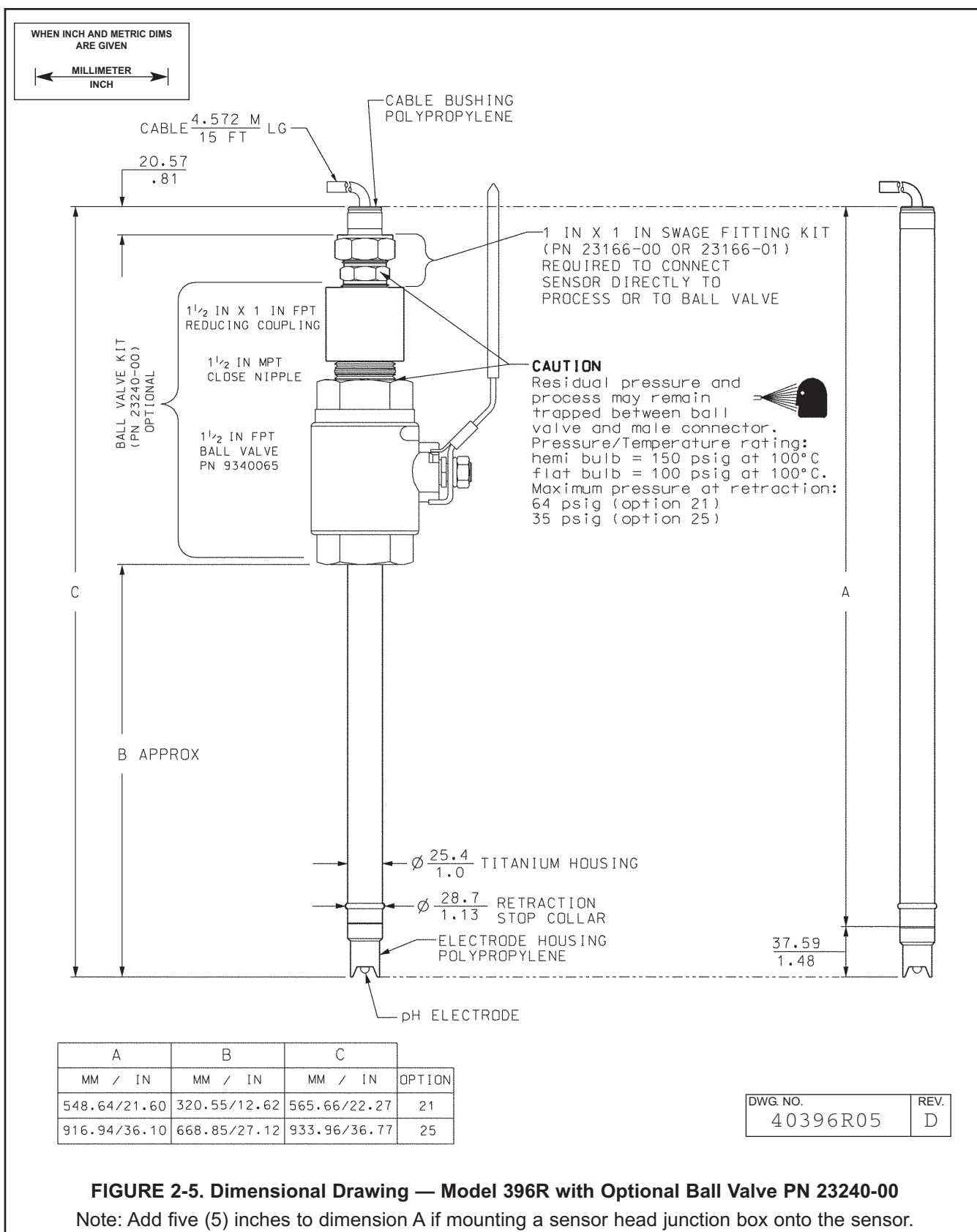
**NOTE**

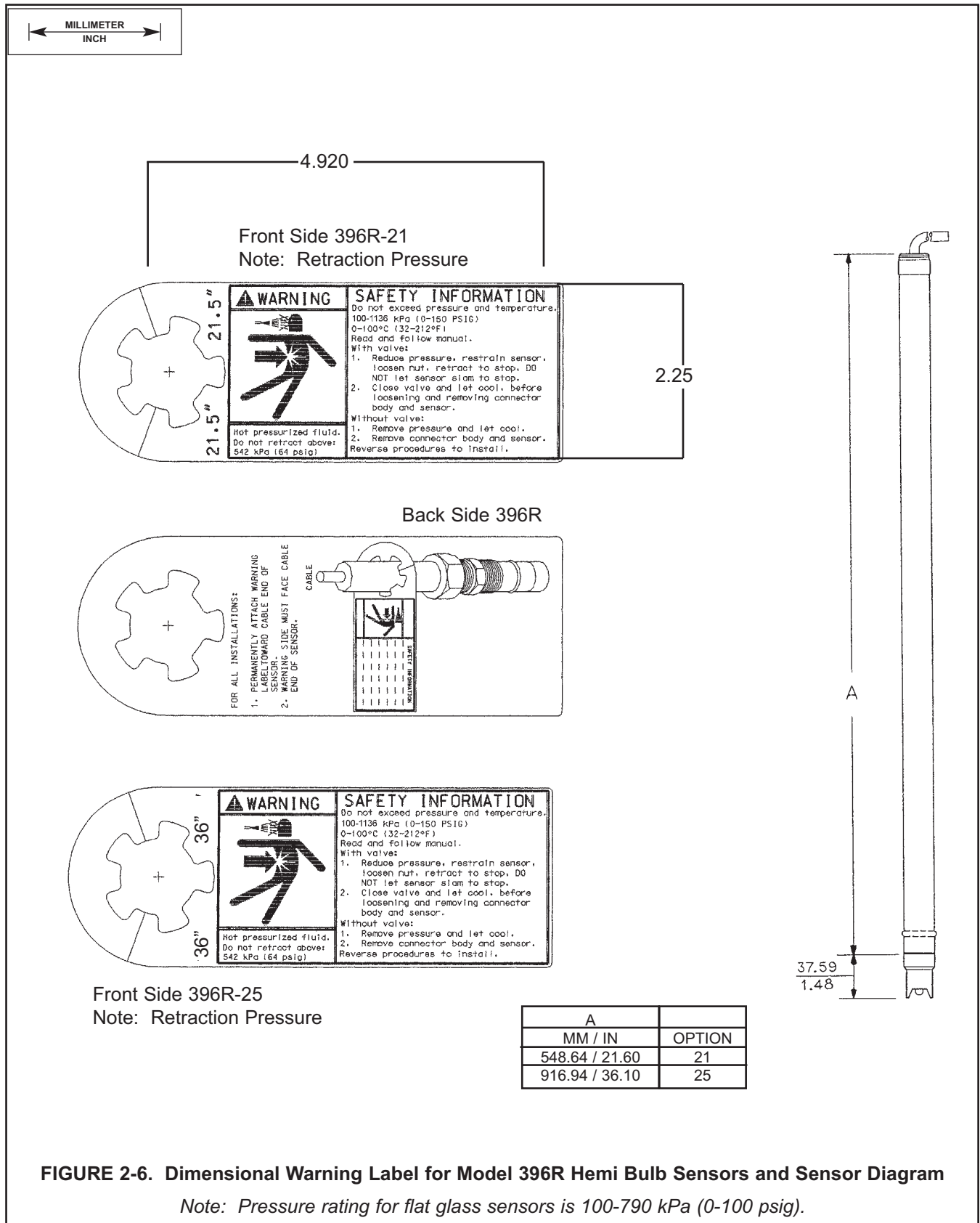
A stainless steel ferrule is available if the Teflon ferrule does not inadequately grip. When using the metallic ferrule, care must be taken to avoid over tightening and damaging the sensor tube. If the male connector leaks during insertion or retraction, replace the O-ring in the male connector.











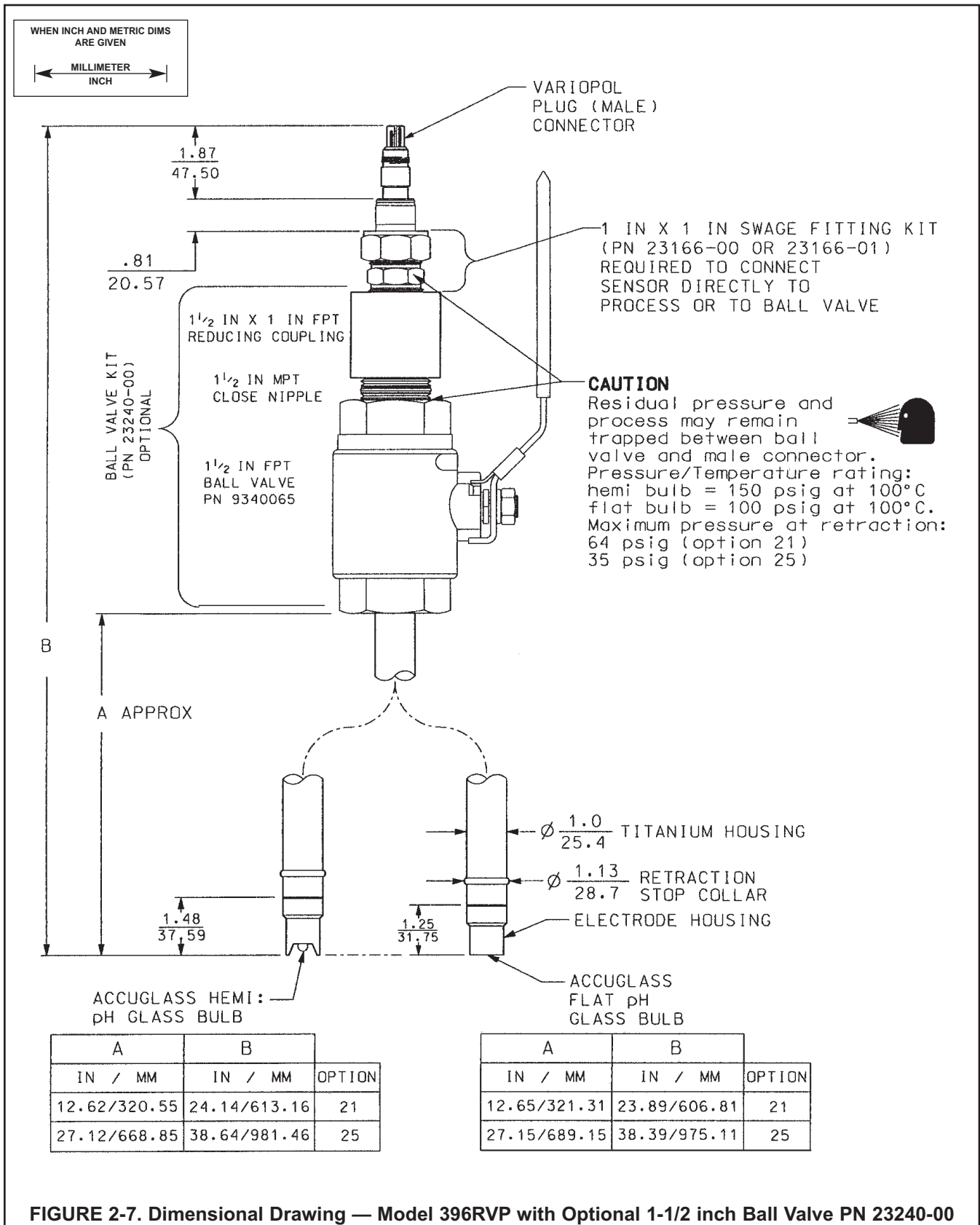


FIGURE 2-7. Dimensional Drawing — Model 396RVP with Optional 1-1/2 inch Ball Valve PN 23240-00



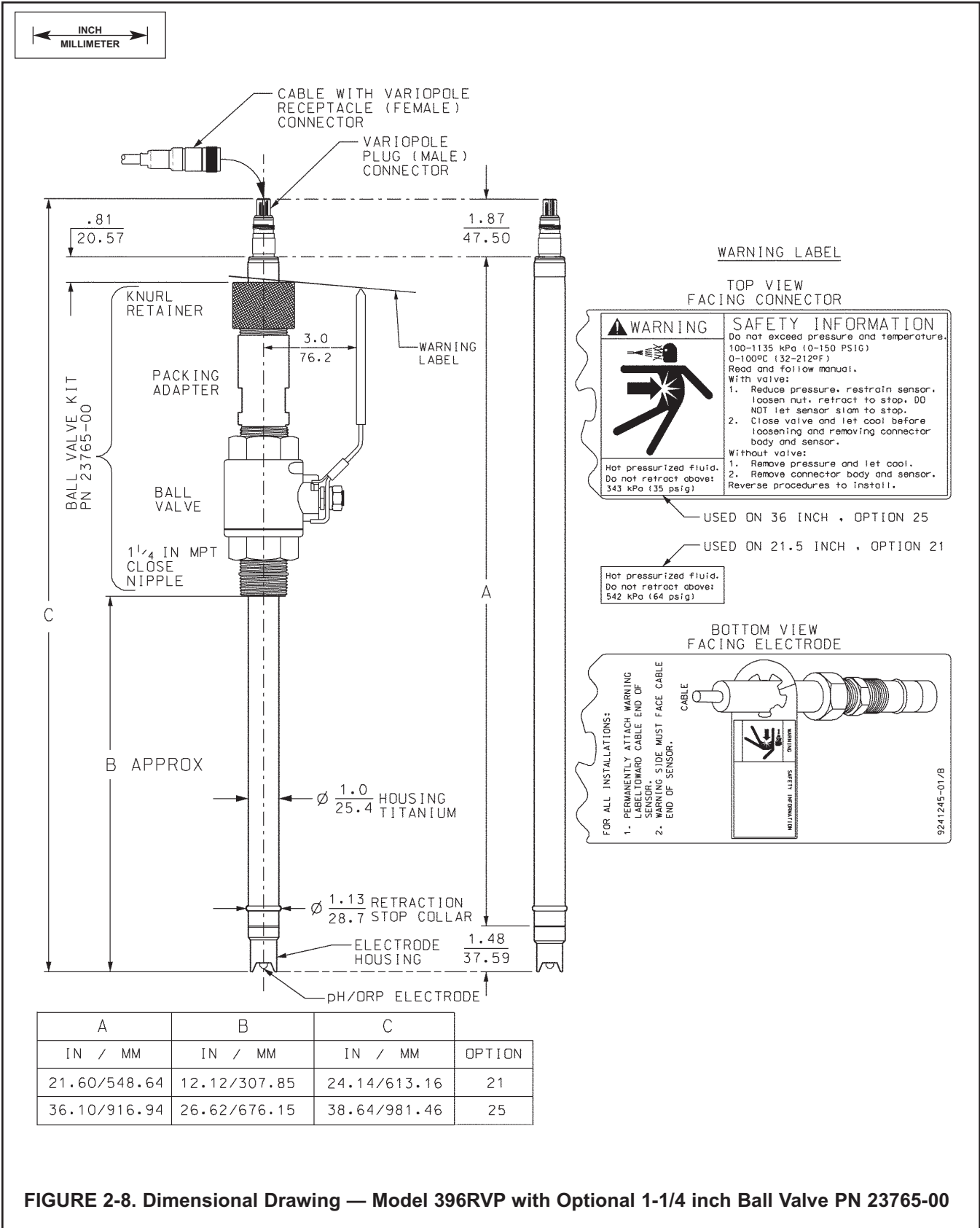


FIGURE 2-8. Dimensional Drawing — Model 396RVP with Optional 1-1/4 inch Ball Valve PN 23765-00

# SECTION 3.0 WIRING MODEL 396R

## WIRING MODEL 396R.

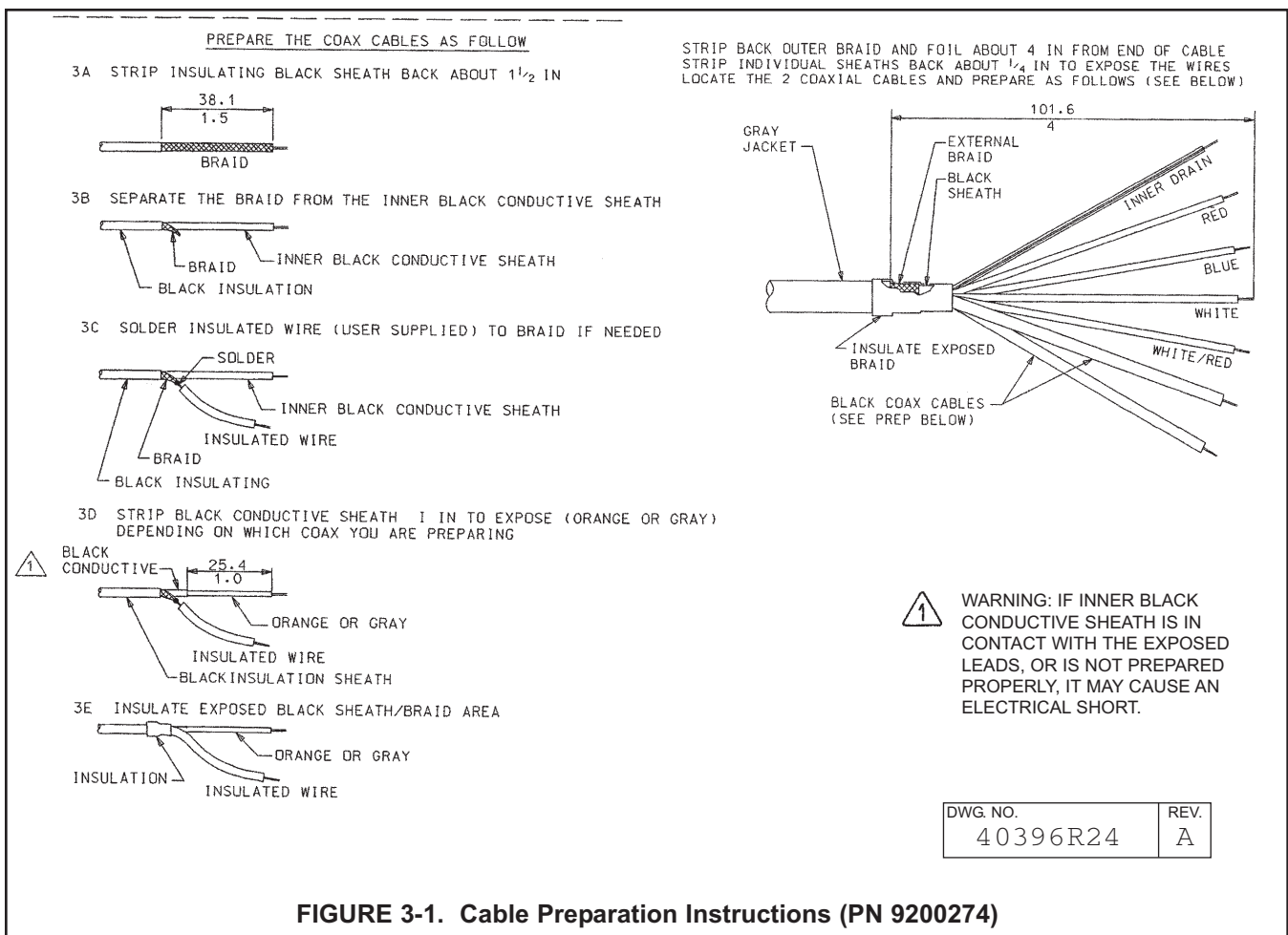
Make electrical connections as shown on Figures 3-1 through 3-15 using the following guidelines. For wiring Model 396RVP, see Section 4.0.

1. Pay particular attention to the analyzer or transmitter model number when following details on the wiring diagrams to ensure that the connections are made to the proper terminals.
2. Use Rosemount custom cable Part Number 9200273 for interconnect.
3. The maximum distance from the sensor to the analyzer is 15 ft without an integral preamplifier.

4. Signal cable should be run in a dedicated conduit and should be kept away from AC power lines.

**NOTE**

For maximum EMI/RFI protection when wiring from the sensor to the junction box, the outer braid of the sensor should be connected to the outer braided shield of the extension cable. The outer braid of the extension cable to the instrument must be terminated at earth ground or by using an appropriate metal cable gland fitting, that provides a secure connection to the instrument cable.



**FIGURE 3-1. Cable Preparation Instructions (PN 9200274)**

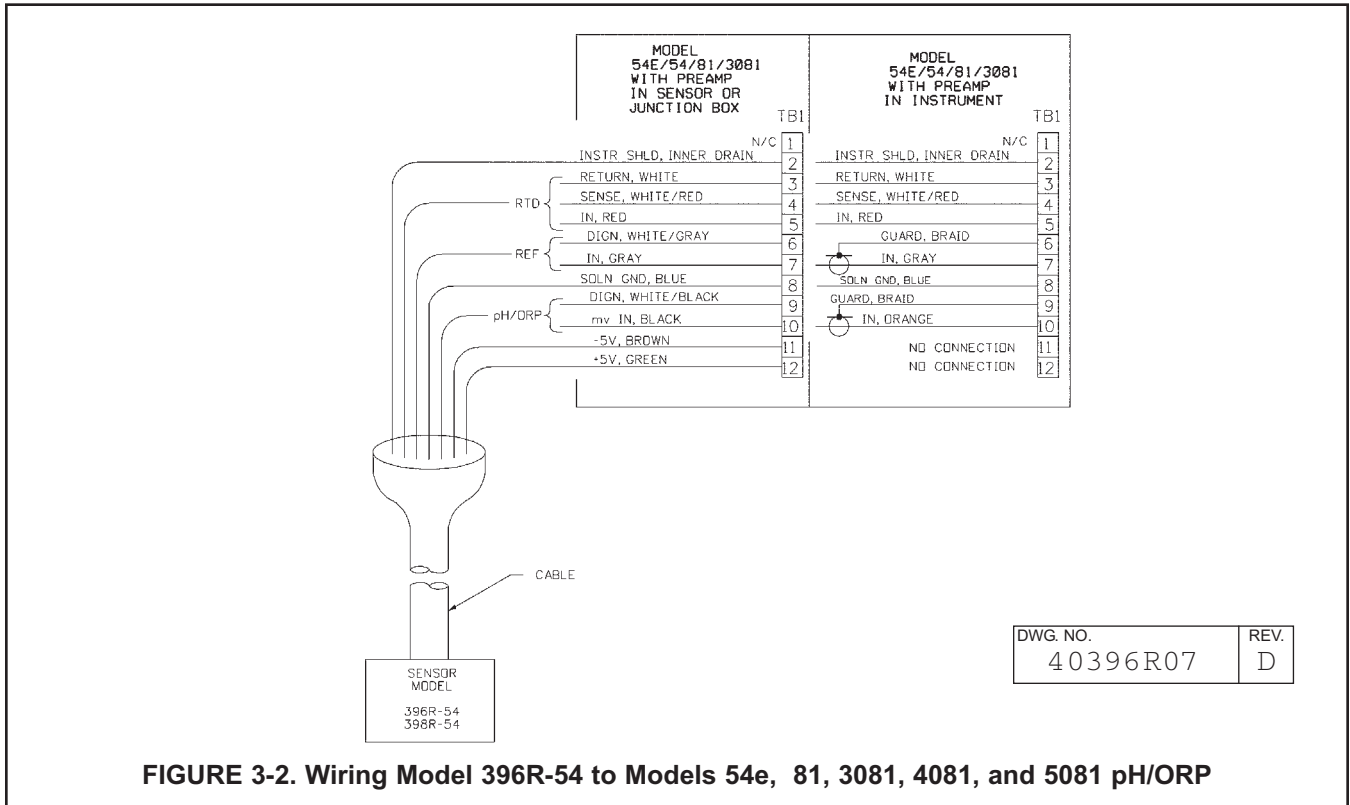


FIGURE 3-2. Wiring Model 396R-54 to Models 54e, 81, 3081, 4081, and 5081 pH/ORP

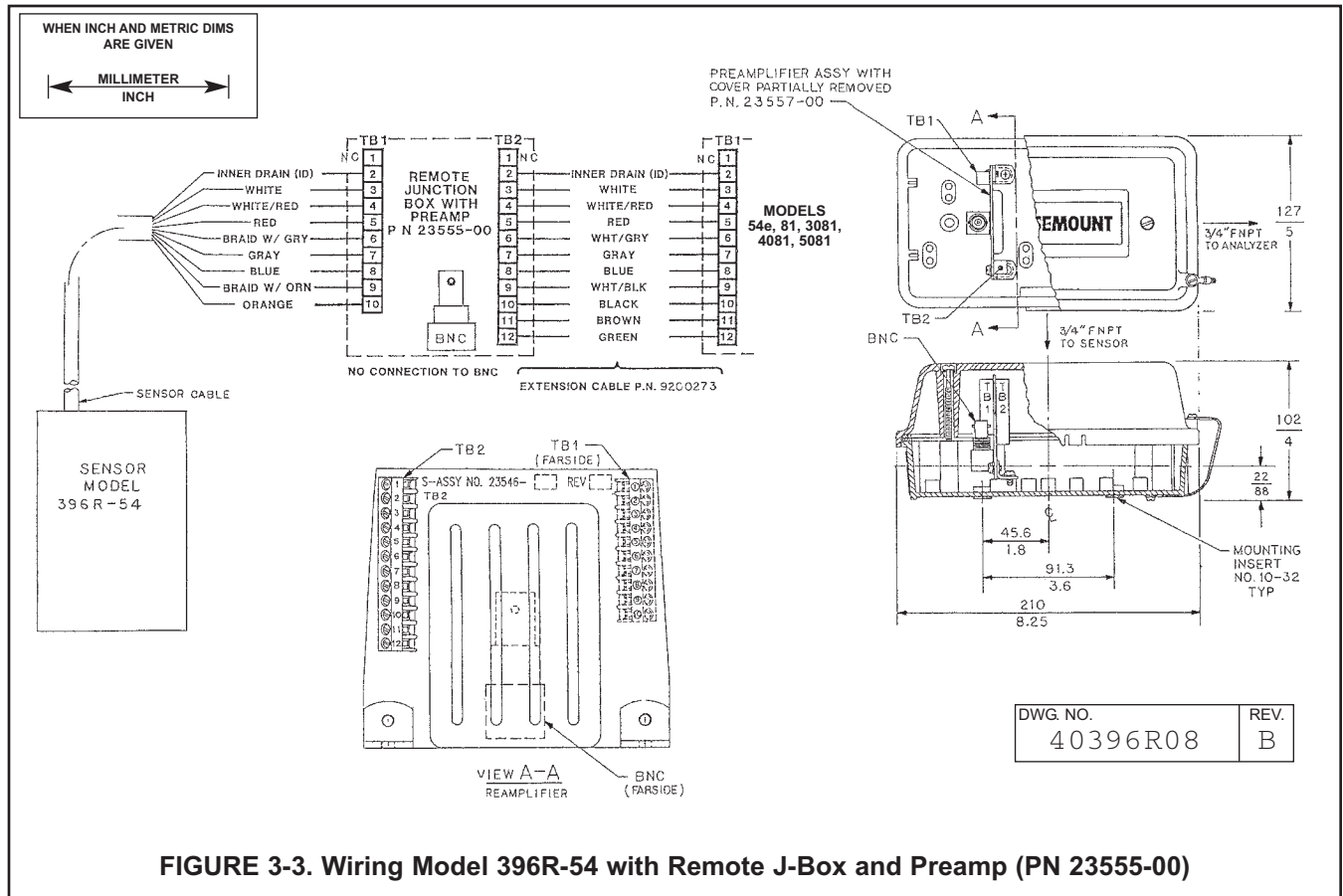


FIGURE 3-3. Wiring Model 396R-54 with Remote J-Box and Preamp (PN 23555-00)

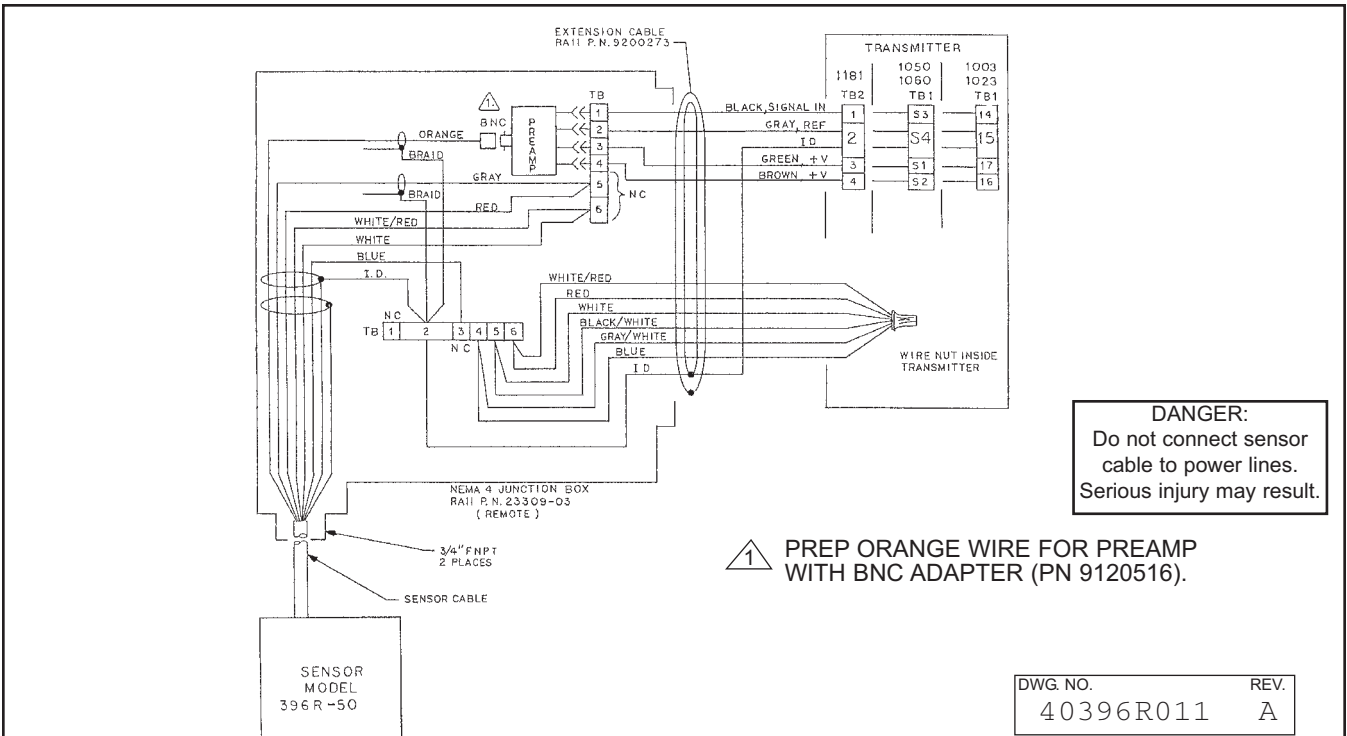


FIGURE 3-4. Wiring Model 396R-50 for use with Remote Junction Box (PN 23309-03)

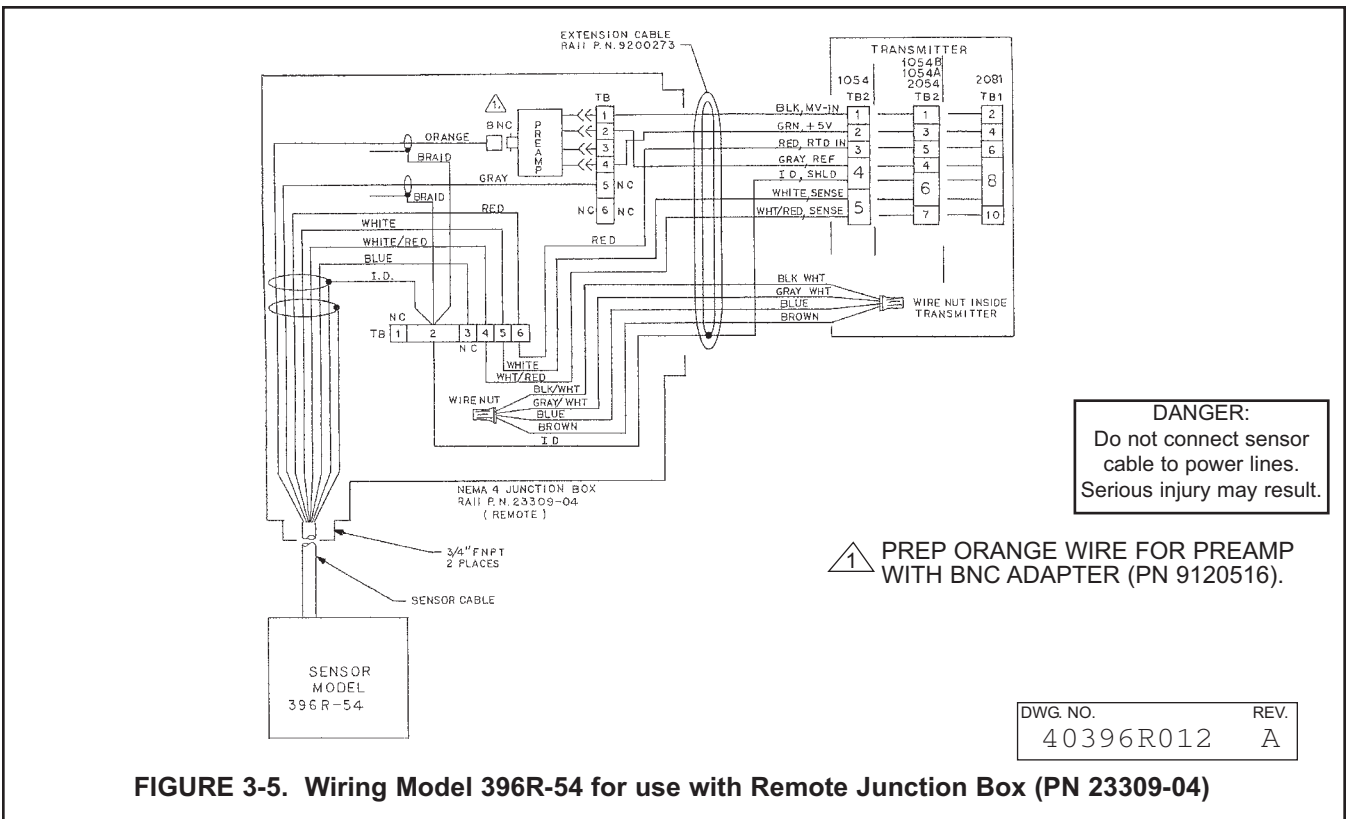
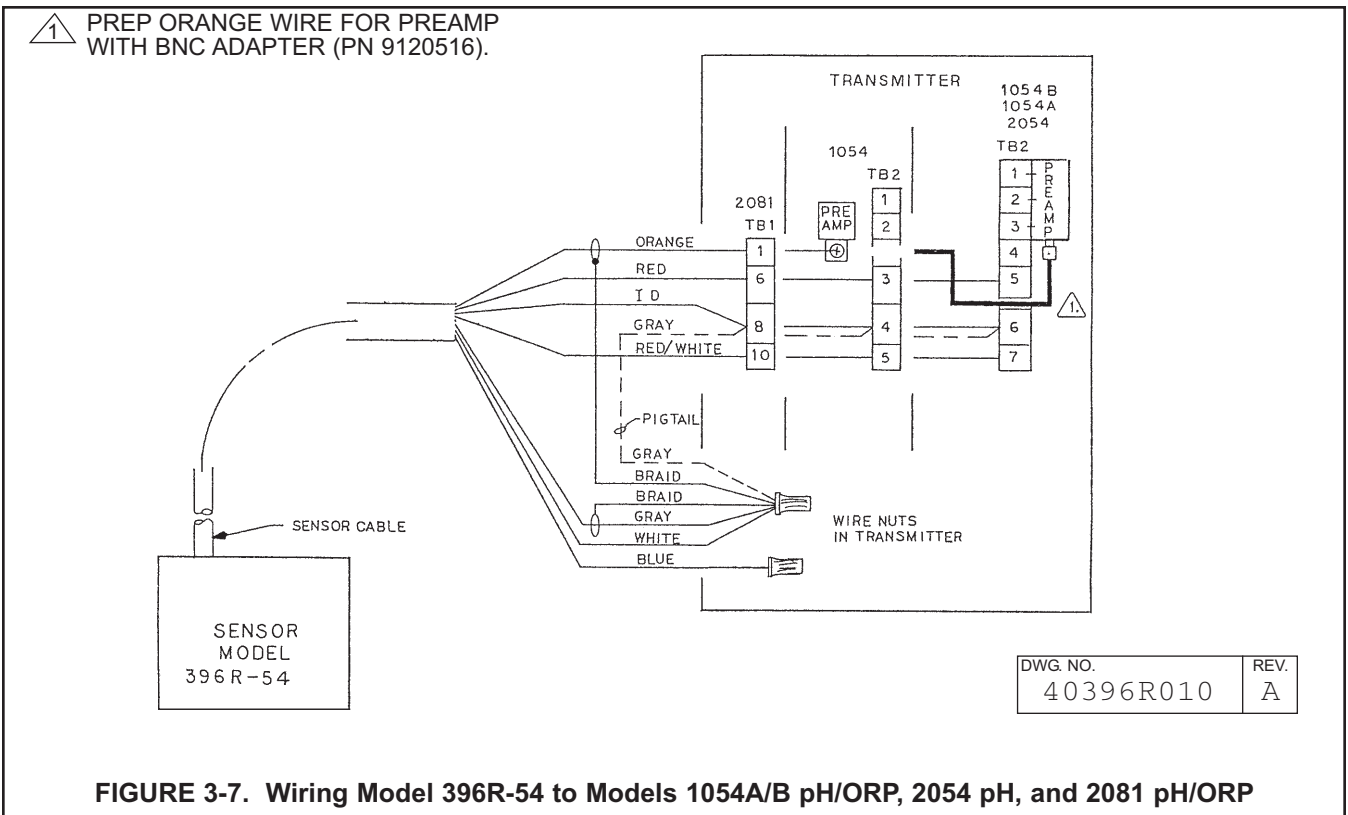
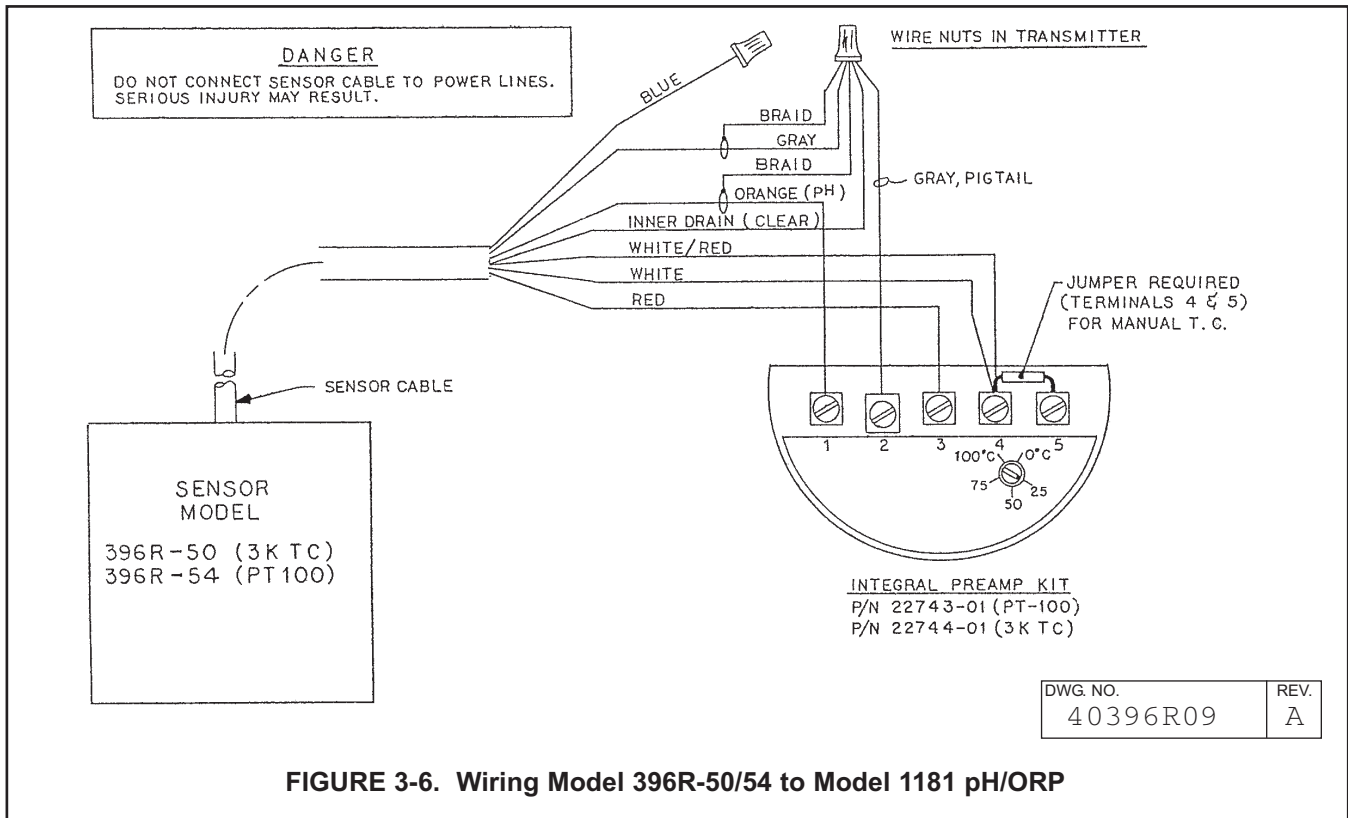


FIGURE 3-5. Wiring Model 396R-54 for use with Remote Junction Box (PN 23309-04)



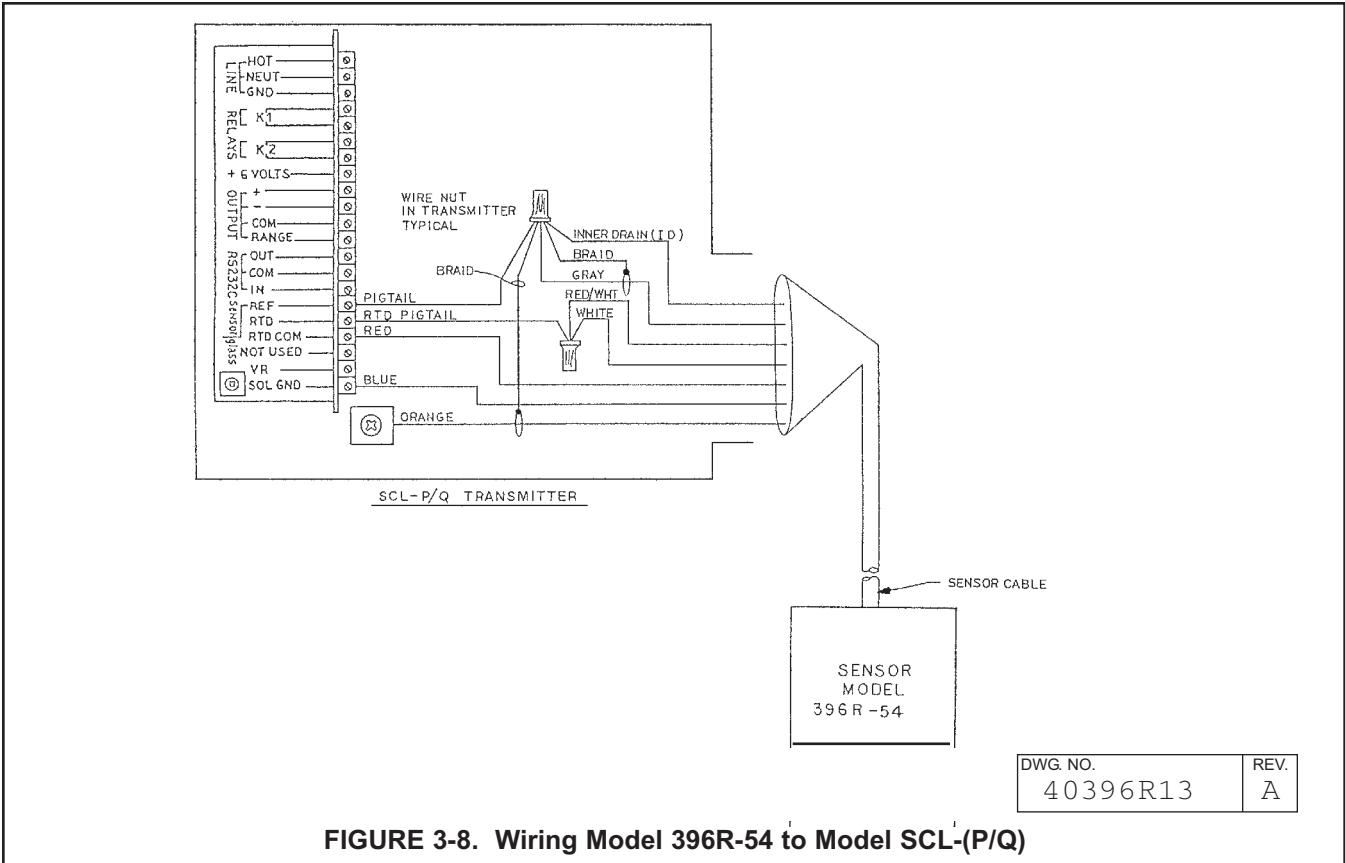


FIGURE 3-8. Wiring Model 396R-54 to Model SCL-(P/Q)

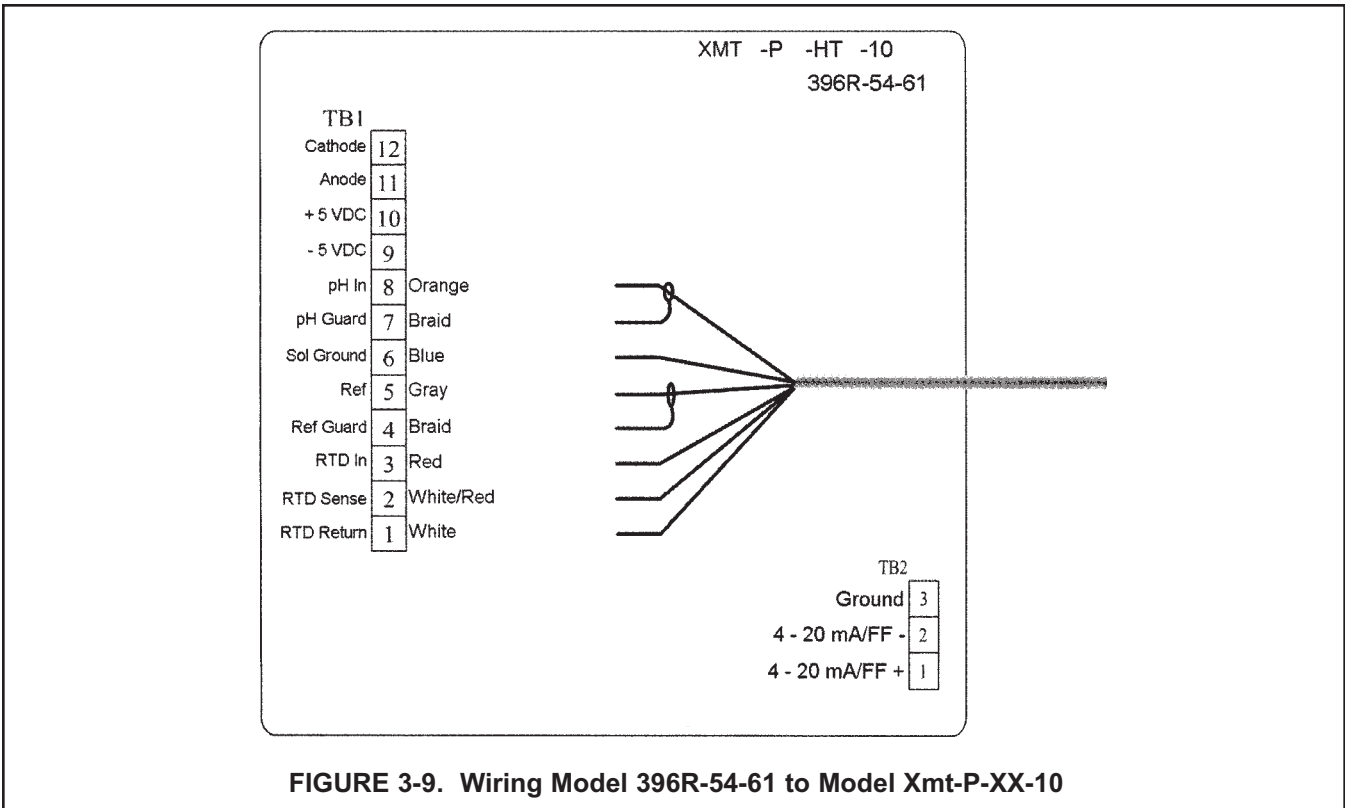
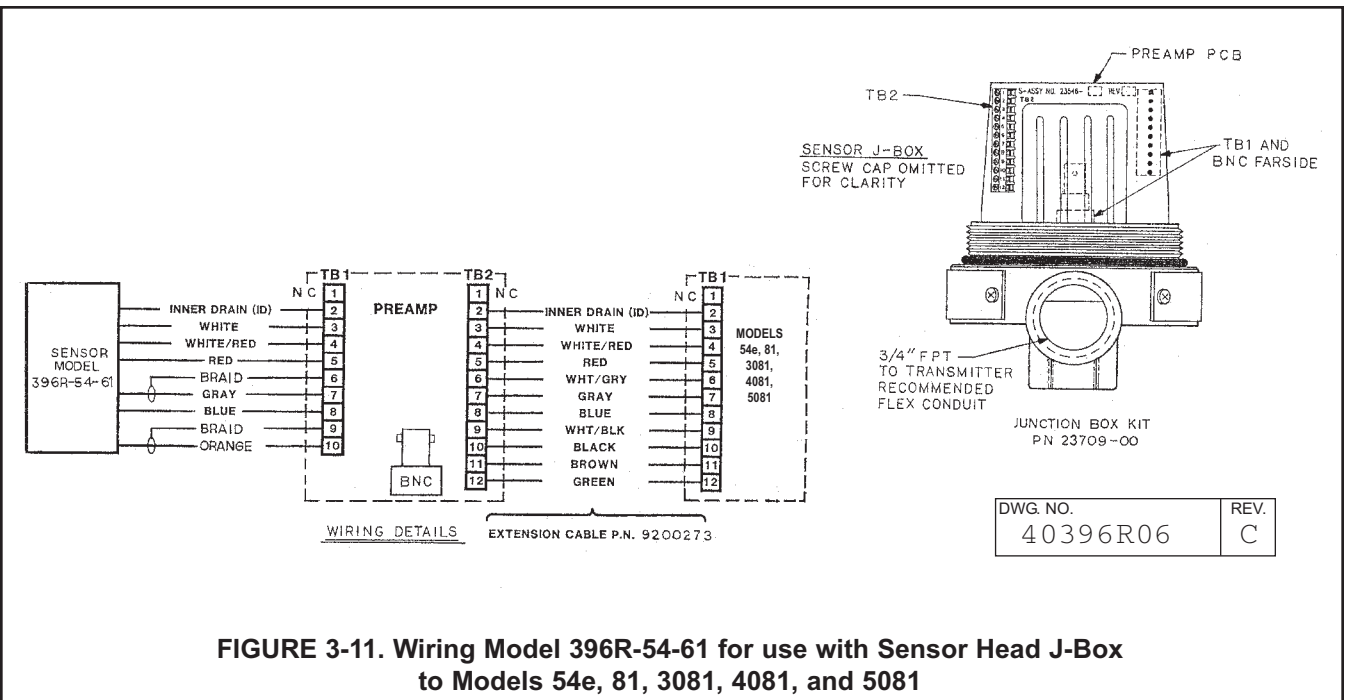
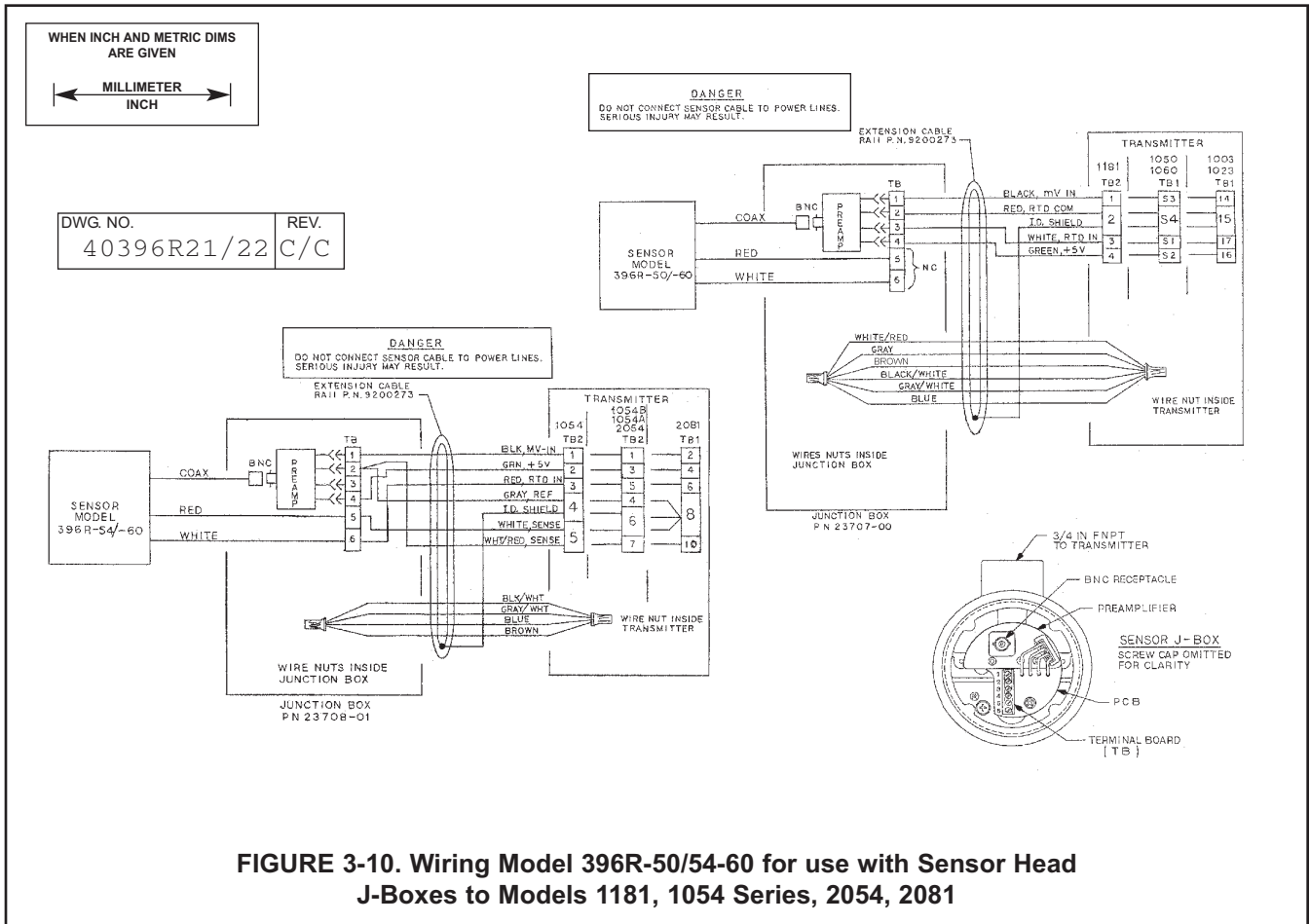
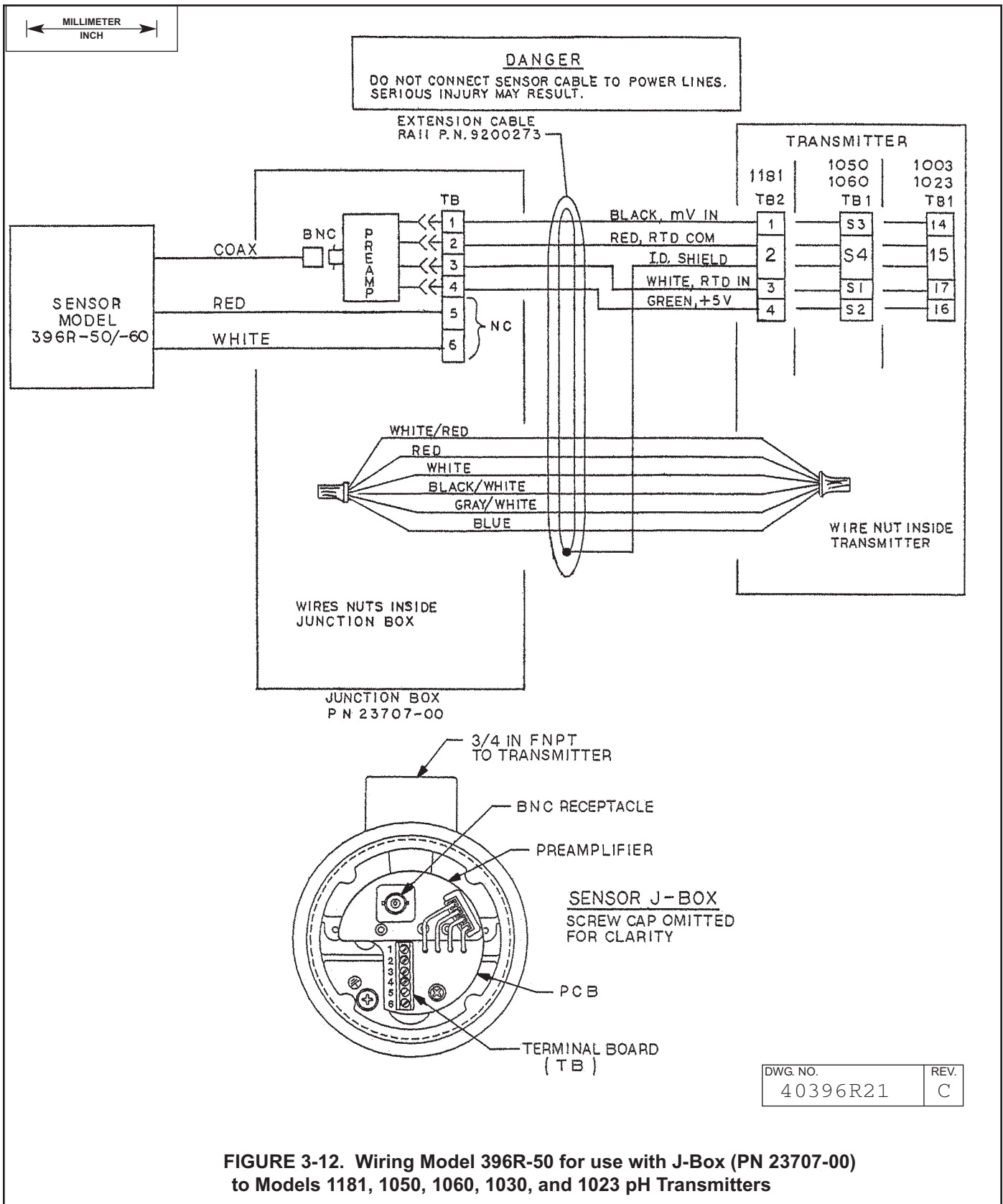


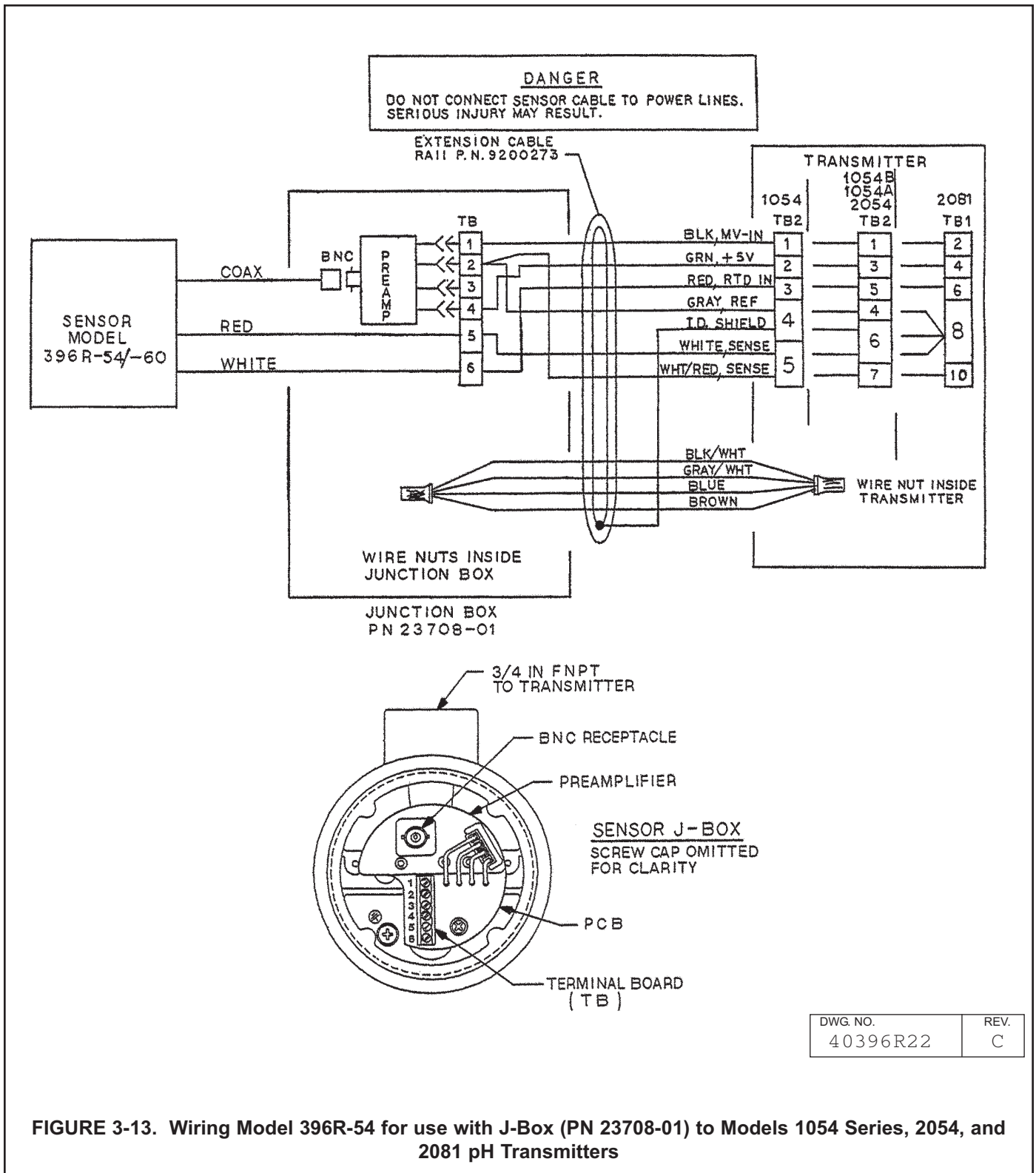
FIGURE 3-9. Wiring Model 396R-54-61 to Model Xmt-P-XX-10

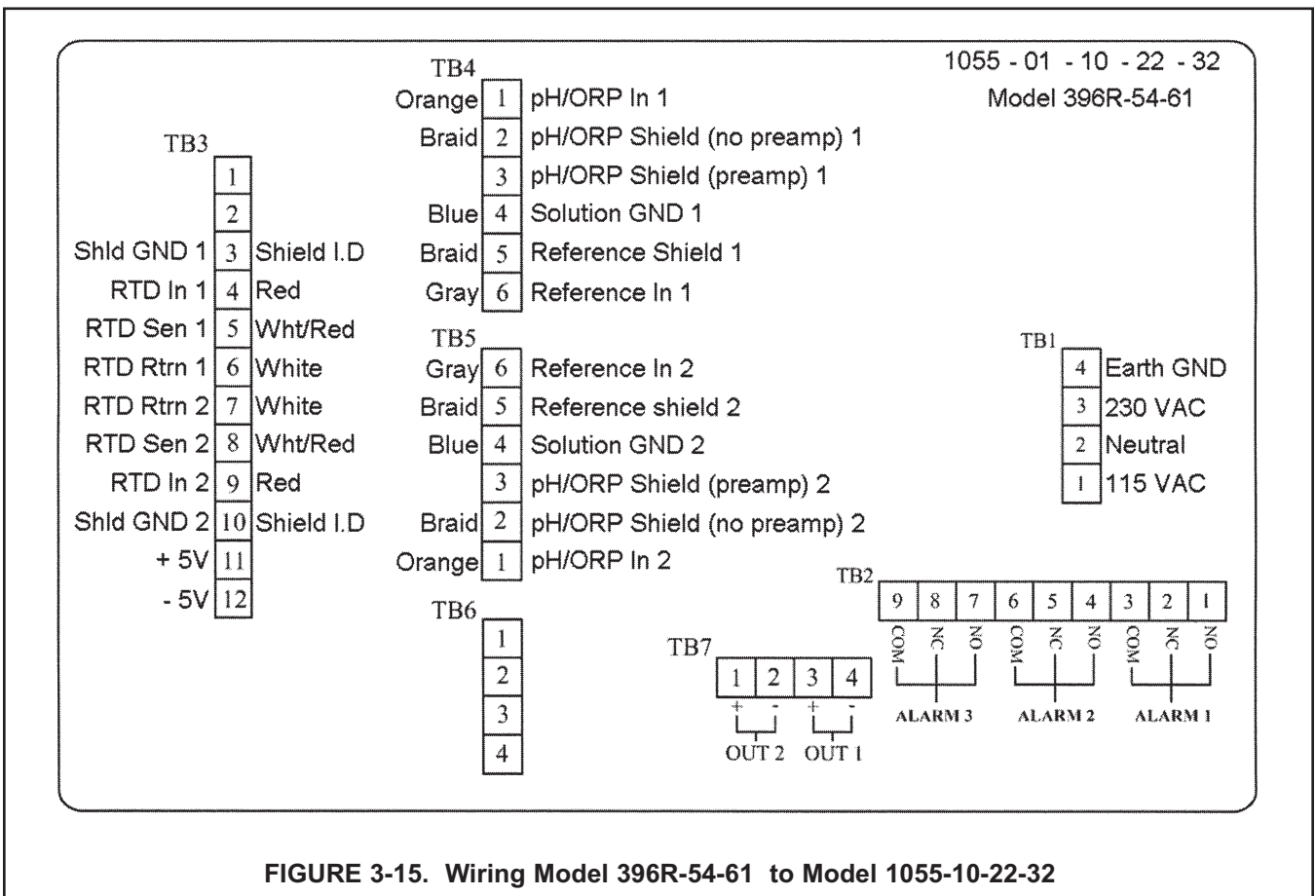
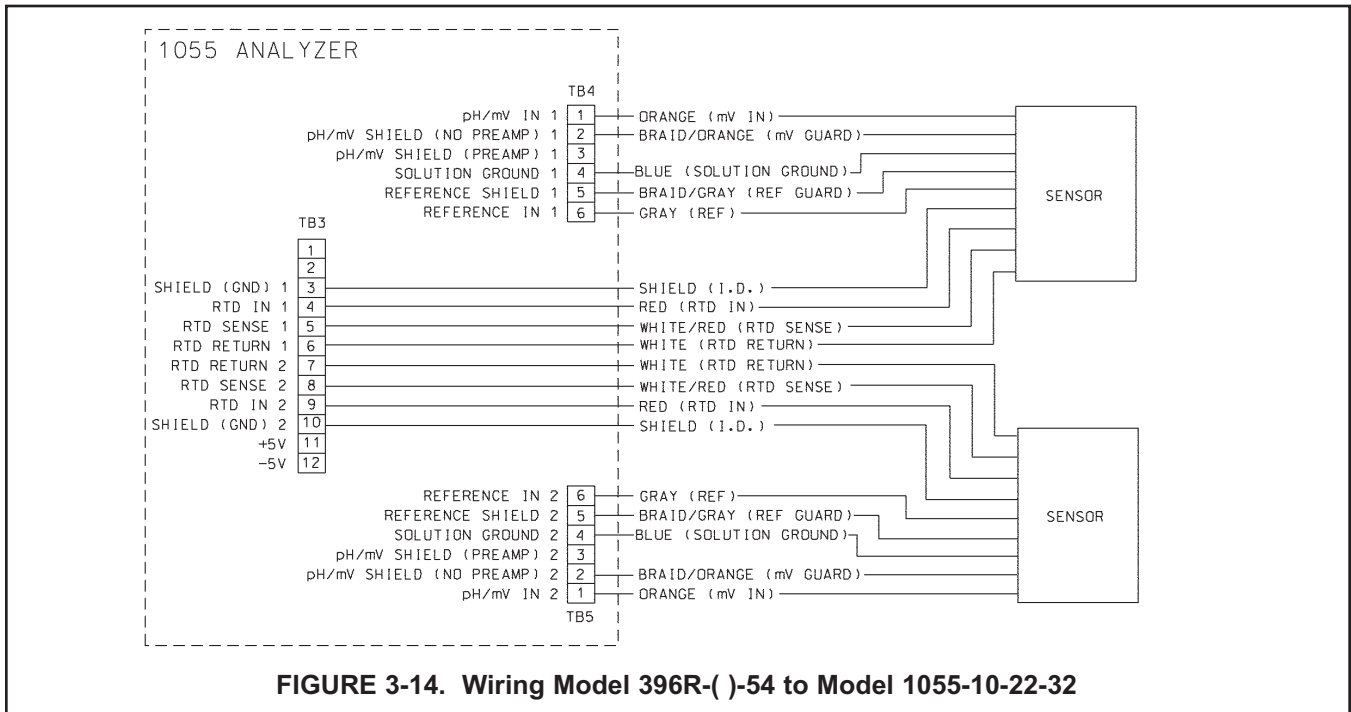




**FIGURE 3-12. Wiring Model 396R-50 for use with J-Box (PN 23707-00) to Models 1181, 1050, 1060, 1030, and 1023 pH Transmitters**







## SECTION 4.0 WIRING MODEL 396RVP

### WIRING MODEL 396RVP.

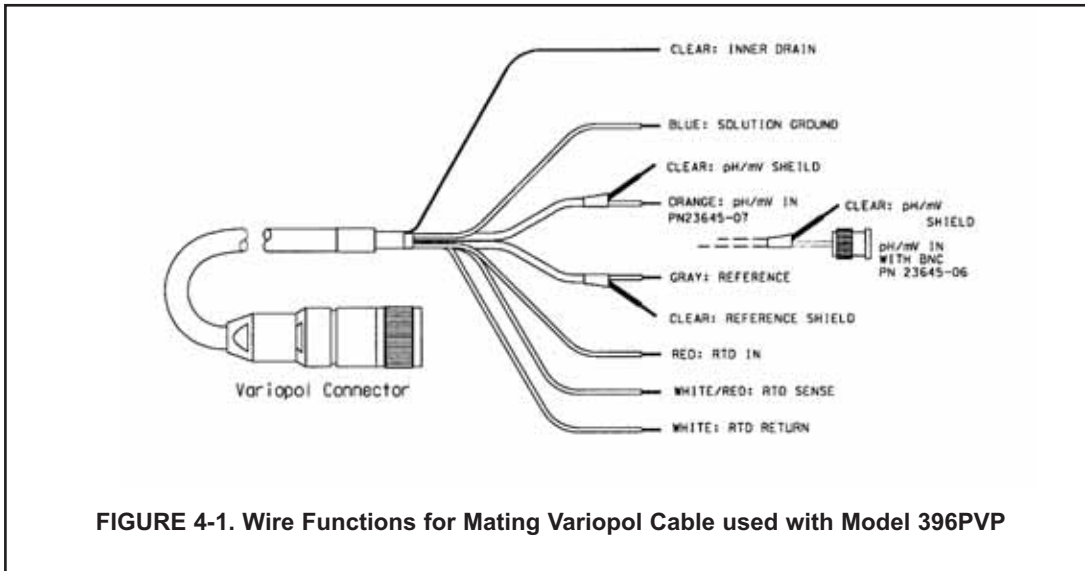
Make electrical connections as shown on Figures 4-1 through 4-21 using the following guidelines. For wiring Model 396R, see Section 3.0.

1. Pay particular attention to the analyzer or transmitter model number when following details on the wiring diagrams to ensure that the connections are made to the proper terminals.
2. The Model 396RVP uses a mating VP cable. The cable part numbers are 23645-06 and 23645-07. See attached wiring sheet for wire functions of the cables and wiring diagrams to various analyzers.
3. The maximum distance from the sensor to the analyzer is 15 ft without an integral preamplifier.

4. Signal cable should be run in a dedicated conduit and should be kept away from AC power lines.

**NOTE**

For maximum EMI/RFI protection when wiring from the sensor to the junction box, the outer braid of the sensor should be connected to the outer braided shield of the extension cable. The outer braid of the extension cable to the instrument must be terminated at earth ground or by using an appropriate metal cable gland fitting, that provides a secure connection to the instrument cable.



**FIGURE 4-1. Wire Functions for Mating Variopool Cable used with Model 396PVP**

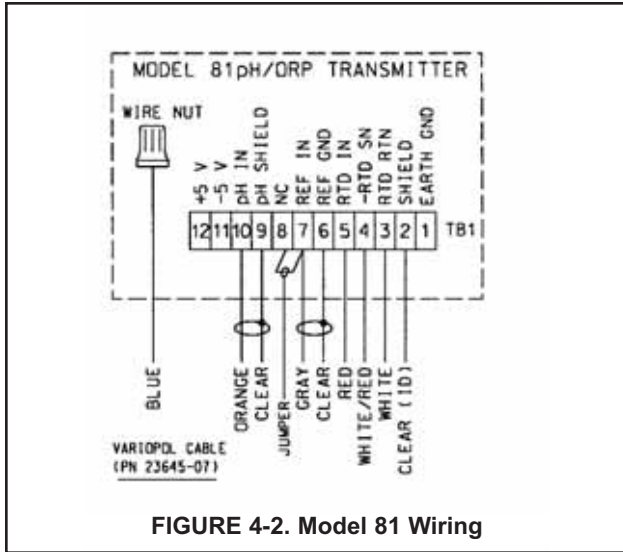


FIGURE 4-2. Model 81 Wiring

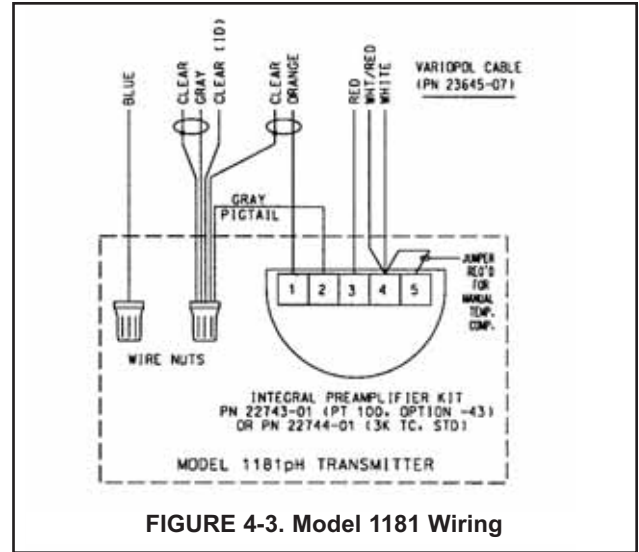


FIGURE 4-3. Model 1181 Wiring

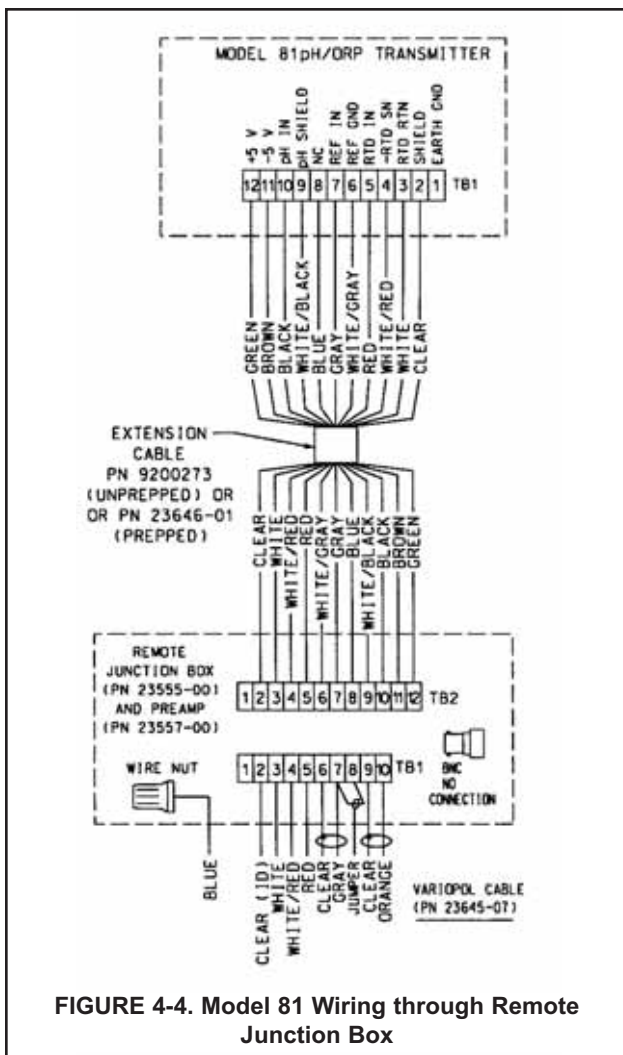


FIGURE 4-4. Model 81 Wiring through Remote Junction Box

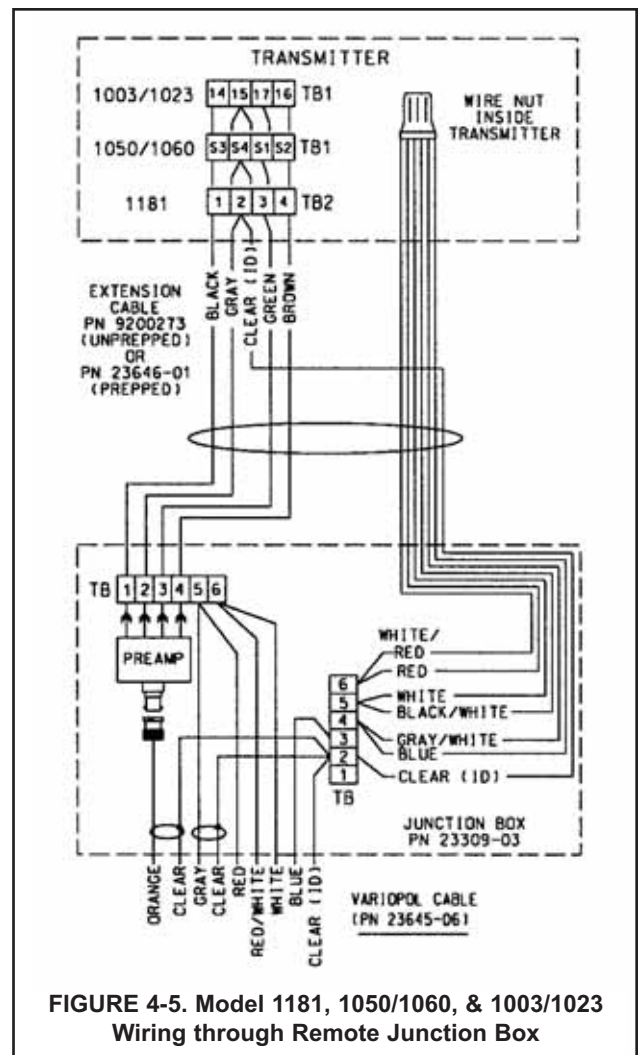


FIGURE 4-5. Model 1181, 1050/1060, & 1003/1023 Wiring through Remote Junction Box

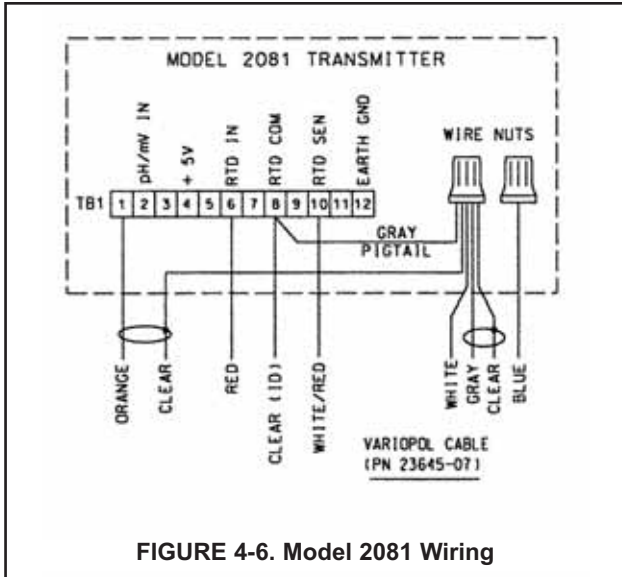


FIGURE 4-6. Model 2081 Wiring

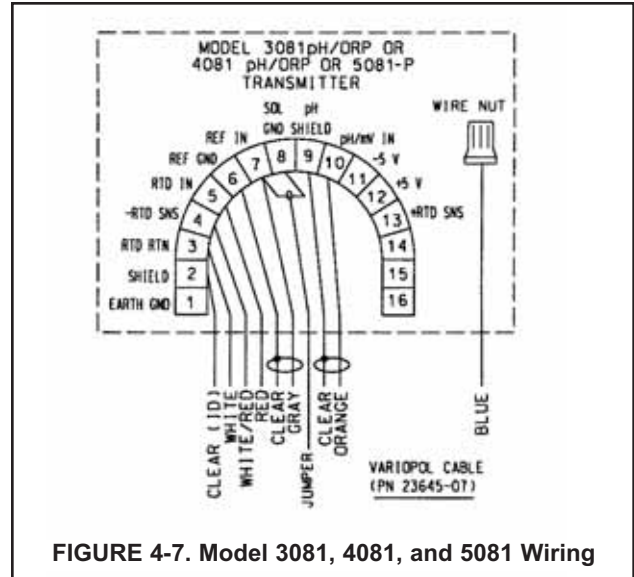


FIGURE 4-7. Model 3081, 4081, and 5081 Wiring

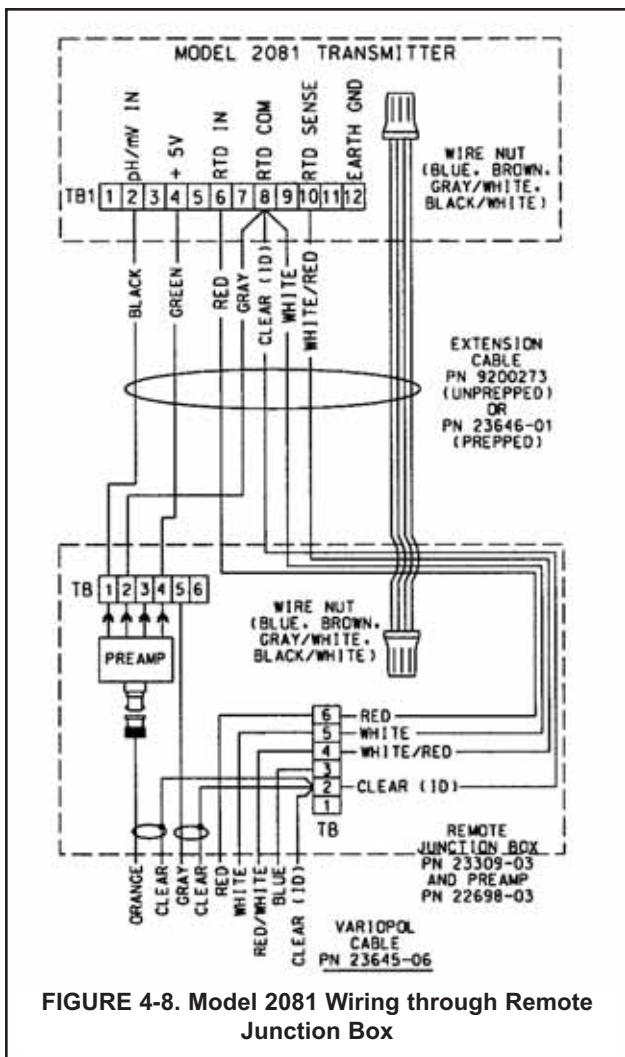


FIGURE 4-8. Model 2081 Wiring through Remote Junction Box

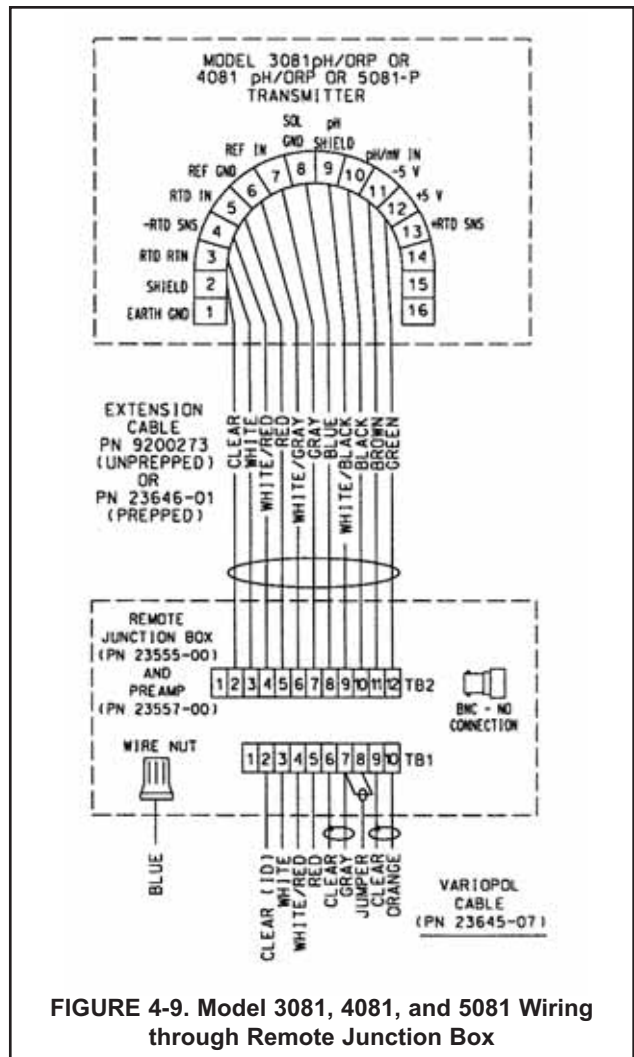


FIGURE 4-9. Model 3081, 4081, and 5081 Wiring through Remote Junction Box

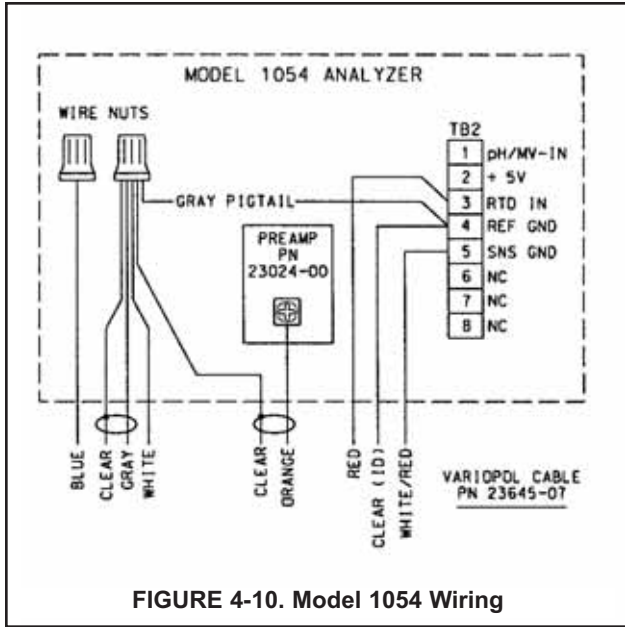


FIGURE 4-10. Model 1054 Wiring

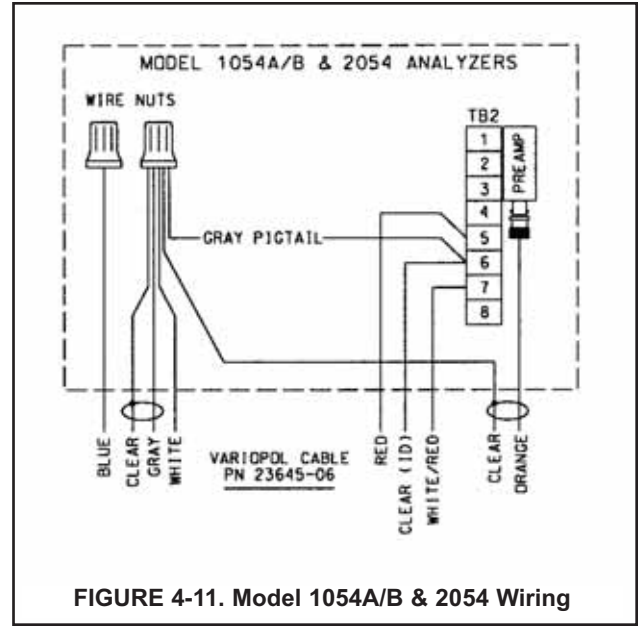


FIGURE 4-11. Model 1054A/B & 2054 Wiring

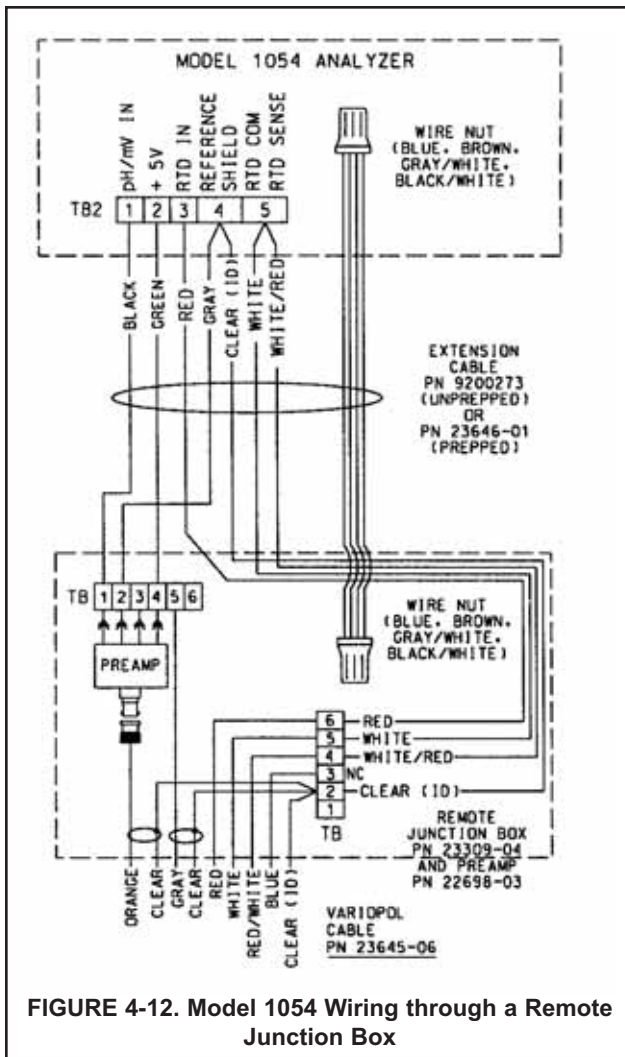


FIGURE 4-12. Model 1054 Wiring through a Remote Junction Box

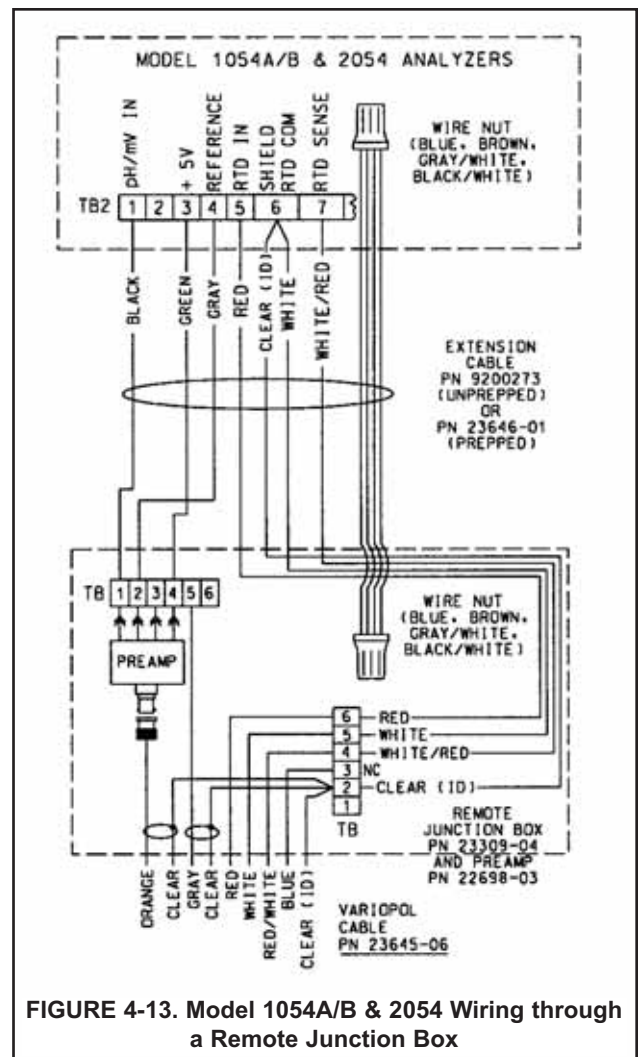


FIGURE 4-13. Model 1054A/B & 2054 Wiring through a Remote Junction Box

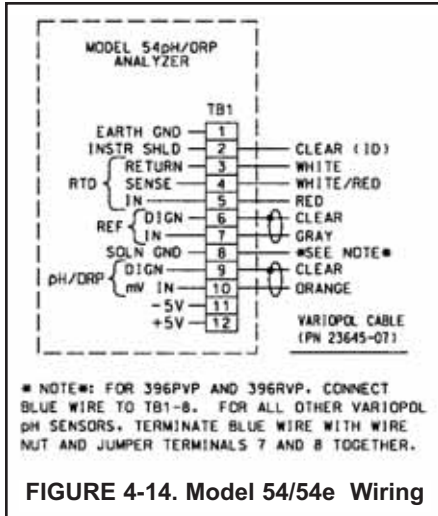


FIGURE 4-14. Model 54/54e Wiring

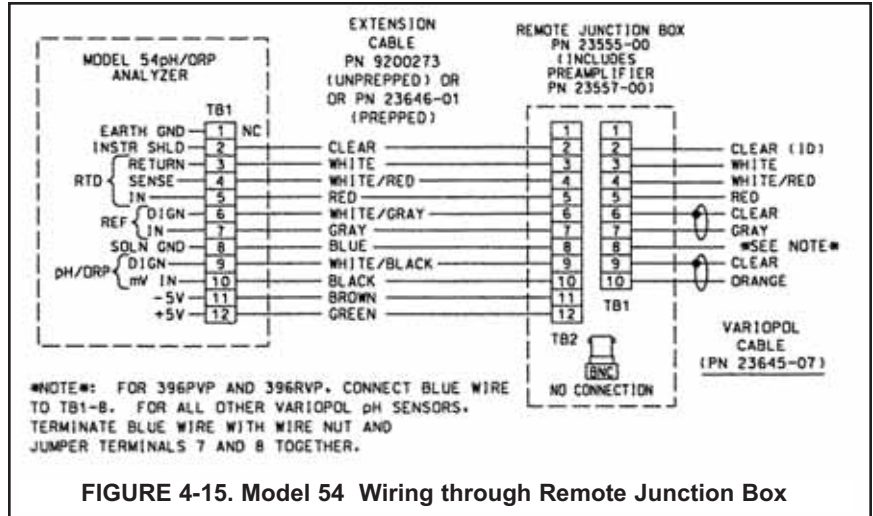


FIGURE 4-15. Model 54 Wiring through Remote Junction Box

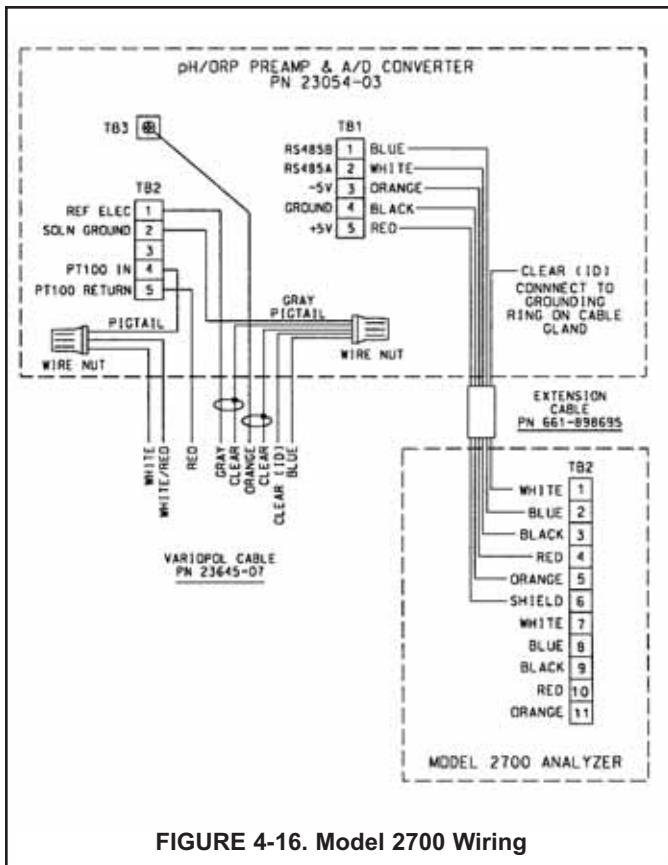


FIGURE 4-16. Model 2700 Wiring

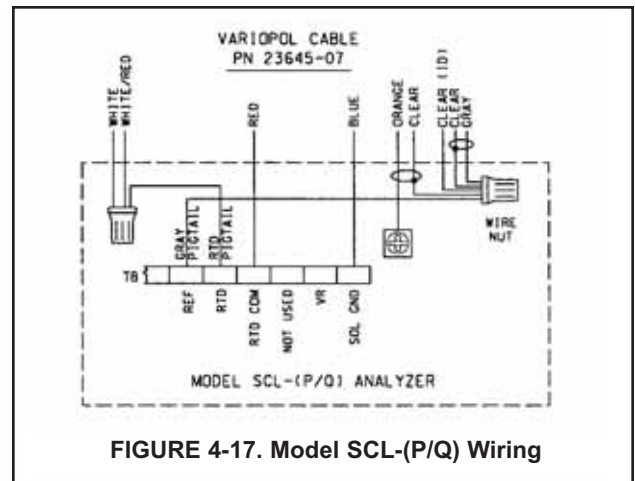


FIGURE 4-17. Model SCL-(P/Q) Wiring

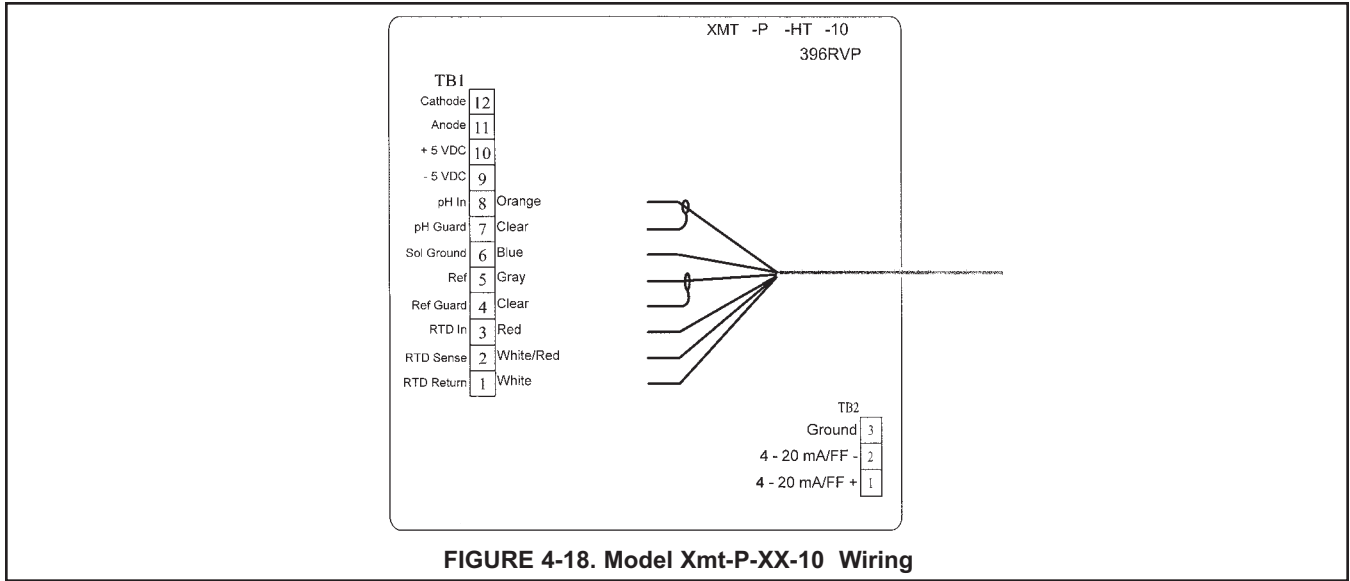


FIGURE 4-18. Model Xmt-P-XX-10 Wiring

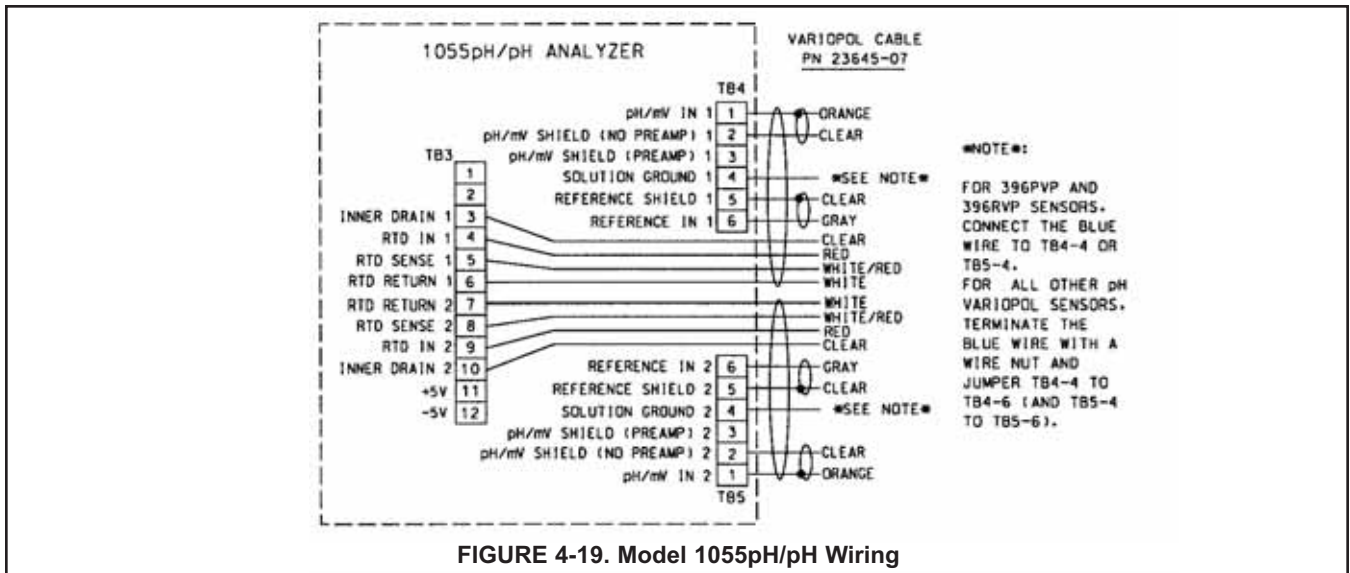


FIGURE 4-19. Model 1055pH/pH Wiring

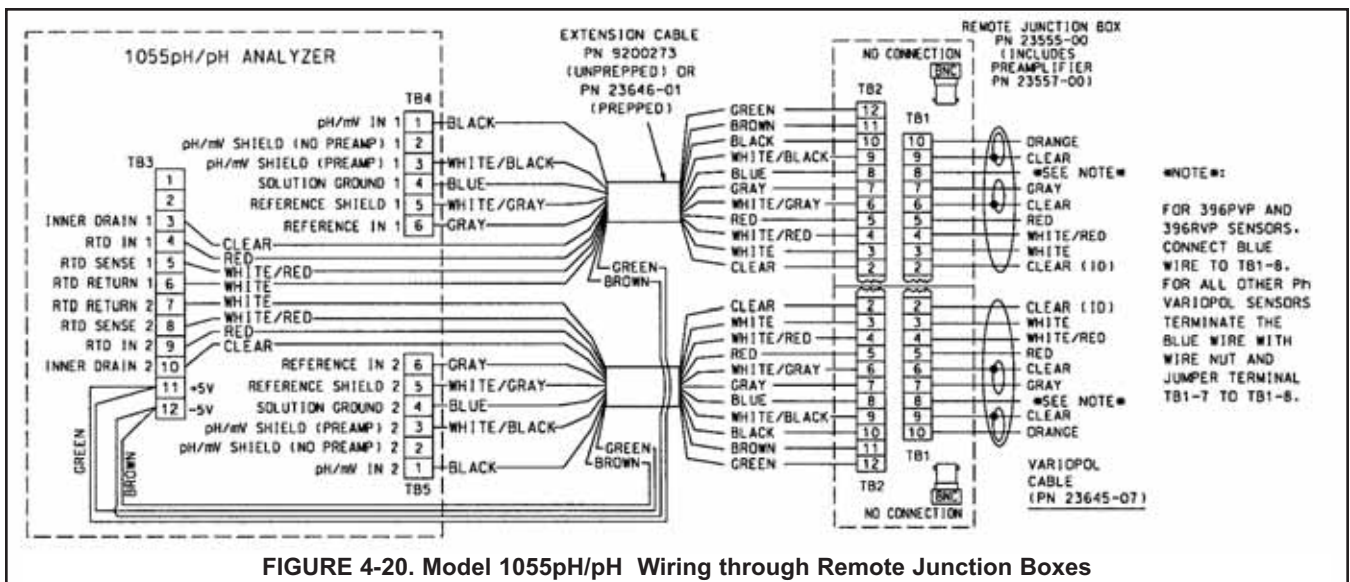


FIGURE 4-20. Model 1055pH/pH Wiring through Remote Junction Boxes



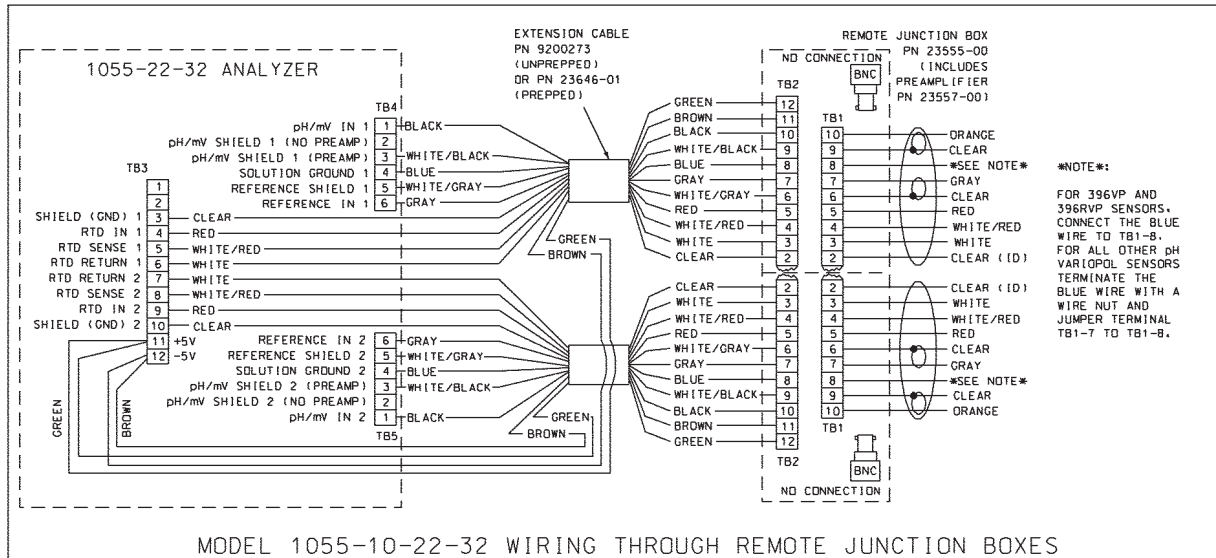
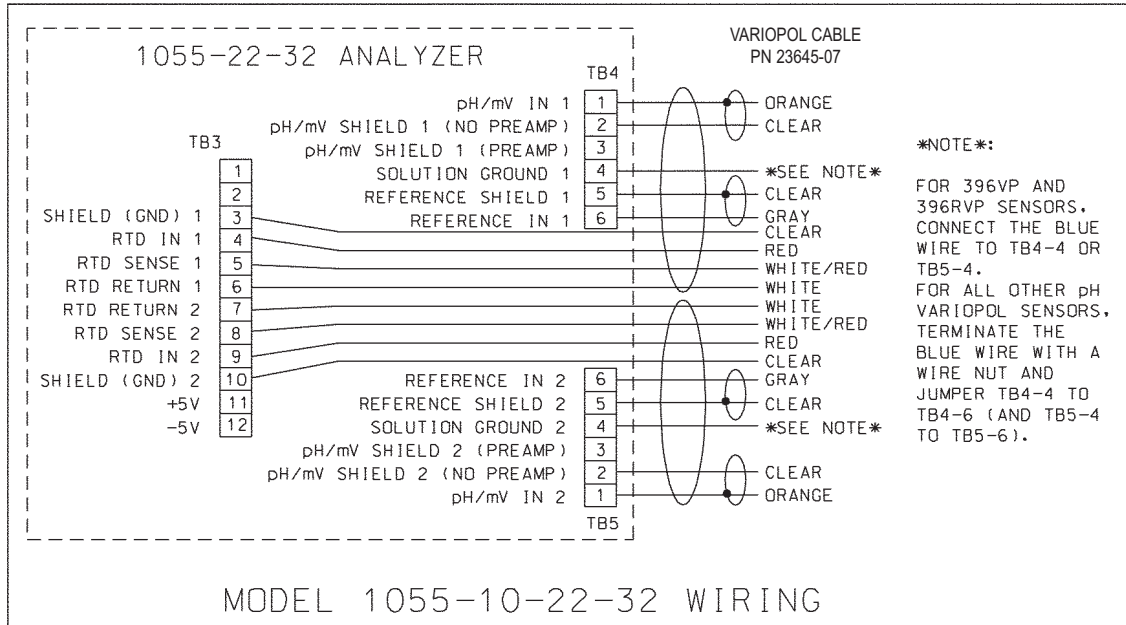


FIGURE 4-21. Model 1055-10-22-32 Wiring

## SECTION 5.0

# START UP AND CALIBRATION

**5.1 START UP.** To obtain best accuracy, the sensor must be calibrated as a loop with the analyzer. Please refer to the respective analyzer/transmitter instruction manual for proper calibration procedures.

### 5.2 396R pH CALIBRATION

1. After a temporary connection is established between the sensor and the instrument, a buffer calibration may be performed.
2. Consult appropriate pH/ORP analyzer or transmitter instruction manual for specific calibration and standardization procedures or see below for recommended two point buffer calibration procedure.

#### 5.2.1 Recommended two point buffer calibration procedure:

Select two stable buffer solutions, preferably pH 4.0 and 10.0 (pH buffers other than pH 4.0 and pH 10.0 can be used as long as the pH values are at least two pH units apart).

**Note:** A pH 7 buffer solution reads a mV value of approx. zero, and pH buffers read approx. +/- 59.1 mV for each pH unit above or below pH 7. Check the pH buffer manufacturer specifications for millivolt values at various temperatures since it may affect the actual value of the buffer solution mV/pH value.

1. Immerse sensor in the first buffer solution. Allow sensor to adjust to the buffer temperature (to avoid errors due to temperature differences between the buffer solution and sensor temperature) and wait for reading to stabilize. Value of buffer can now be acknowledged by analyzer/transmitter
2. Once the first buffer has been acknowledged by the analyzer/transmitter, rinse the buffer solution off of the sensor with distilled or deionized water.
3. Repeat steps 1 and 2 using the second buffer solution.
4. Once the analyzer/transmitter has acknowledged both buffer solutions, a sensor slope (mV/pH) is established (the slope value can be found within the analyzer/transmitter).
5. The slope value should read about 59.1 mV/pH for a new sensor and will decrease over time to approximately 47 - 49 mV/pH. Once the slope reads below the 47-49 mV/pH range, a new sensor should be installed to maintain accurate readings.

#### 5.2.2 Recommended pH Sensor Standardization

For maximum accuracy, the sensor can be standardized on-line or with a process grab sample after a buffer calibration has been performed and the sensor has been conditioned to the process. Standardization accounts for the sensor junction potential and other interferences. Standardization will not change the sensor's slope but will simply adjust the analyzers reading to match that of the known process pH.

1. While obtaining a process solution sample (it is recommended that the sample is taken close to the sensor), record the pH value that is shown on the analyzer/transmitter display.
2. Measure and record the pH of the process solution sample with a another temperature compensated, calibrated pH instrument. For best results, standardization should be performed at the process temperature.
3. Adjust the analyzer/transmitter value to the standardized value.

**5.3 396R ORP CALIBRATION.** An ORP loop is best calibrated using an ORP standard solution. Most industrial applications have a number of ORP reactions occurring in sequence or simultaneously. There can be several components that are oxidized or reduced by the reagents that are used. Theoretically, the ORP potential is absolute because it is the result of the oxidation-reduction equilibrium. However, the actual measured potential is dependent on many factors, including the condition of the surface of the ORP platinum electrode. **Therefore, the sensor should be allowed 1-2 hours to become “conditioned” to the stream when first set-up or after being cleaned.**

**5.3.1 ORP Calibration Procedure**

1. Make a temporary electrical connection between the sensor and the instrument.
2. Obtain a ORP standard solution (PN R508-8oz) or one can be made quite simply by adding a few crystals of quinhydrone to either pH 4 or pH 7 buffer. Quinhydrone is only slightly soluble; therefore, only a few crystals will be required.

3. Immerse the sensor in the standard solution. Allow 1-2 minutes for the ORP sensor to stabilize.
4. Adjust the standardize control of the instrument to the solution value shown in Table 5-1. The resulting potentials, measured with a clean platinum electrode and saturated KCl/AgCl reference electrode, should be within  $\pm 20$  millivolts of the value shown in Table 5-1. Solution temperature must be noted to insure accurate interpretation of results. The ORP value of saturated quinhydrone solution is not stable over long periods of time. Therefore, these standards should be made up fresh each time they are used.
5. Remove the sensor from the buffer, rinse and install in the process.

**TABLE 5-1  
ORP of Saturated Quinhydrone Solution**

	pH 4			pH 7		
TEMPERATURE °C	20	25	30	20	25	30
Millivolt Potential	268	264	260	94	87	80

## SECTION 6.0 MAINTENANCE

**6.1 Maintenance.** The Model 396R Sensor is a disposal type sensor and therefore requires minimum maintenance. The sensor should be removed from the process periodically and checked in buffer solutions. If the sensor will not calibrate, refer to your analyzer/transmitters instruction manual for proper test procedures. If the sensor has failed, it should be discarded and replaced.

**6.2 Sensor Removal.** Please refer to the appropriate paragraph for instructions regarding removal of the sensor for periodic maintenance.

**6.2.1 Retractable Version.**

<b>WARNING</b>
System pressure may cause the sensor to blow out with great force unless care is taken during removal. Make sure the following steps are adhered to.

**A. Model 396R-21 (21" tube)**

1. Be certain system pressure at the sensor is below 64 psig (542 kPa) before proceeding with the retraction. It is also recommended that the personnel wear a face shield and have a stable footing. Refer to Figure 6-1. Push in on the sensor end or the top of the J-box and slowly loosen the hex nut (B) of the process end male connector (A).

**B. Model 396R-25 (36" tube)**

2. Be certain that pressure at the sensor is below 35 psig (343 KPa) before proceeding with the retraction. It is also recommended that the personnel wear a face shield and have a stable footing. Refer to Figure 6-1. Push in on the sensor end or the top of the J-box and slowly loosen the hex nut (B) of the process end male connector (A).

<b>CAUTION</b>
Do not remove nut at this time.

3. When the hex nut is loose enough, slowly ease the sensor back completely until the retraction stop collar is reached.

<b>CAUTION</b>
Failure to withdraw the sensor completely may result in damage to the sensor when the valve is closed.

4. Close the ball valve slowly. If there is resistance, the valve may be hitting the sensor. Double check that the sensor has been retracted to the retraction stop collar.

<b>WARNING</b>
Before removing the sensor from the ball valve, be absolutely certain that the ball valve is fully closed. Leakage from the male connector threads may indicate that the male connector is still under pressure. Leakage through a partially open valve could be hazardous, however with the ball valve closed, some residual process fluid may leak from the connector's pipe threads.

5. The Male Connector Body (A) may now be completely unthreaded from the reducing coupling and the sensor removed for servicing.

<b>CAUTION</b>
If the male connector leaks during insertion or retraction, replace the O-ring (PN 9550099) in the male connector A.

**6.3 pH Electrode Cleaning.** If the electrode is coated or dirty, it may be cleaned as follows:

1. Remove the sensor from process as instructed in Section 6.2.
2. Wipe the glass bulb with a soft, clean, lint free cloth or tissue. If this does not remove the dirt or coating, proceed to step 3. If the sensor appears to be clean, go to step 5.
3. Wash the glass bulb in a strong detergent solution and thoroughly rinse with tap water. If the bulb still appears to have a coating, proceed to step 4.

<b>CAUTION</b>
The solution used in the following step is an acid and should be handled with care. Follow the directions of the acid manufacturer. Wear the proper protective equipment. Do not let the solution come in contact with skin or clothing. If contact with the skin is made, immediately rinse with clean water.

4. Following the caution above, wash the glass bulb in dilute 5% hydrochloric acid solution and then rinse it thoroughly in tap water. Replace the sensor if it cannot be cleaned. If the glass bulb appears clean, proceed to step 5.
5. Buffer calibrate the sensor (Refer to Section 5.0). If the sensor appears to respond sluggishly to pH change, soaking it overnight in a weak acid solution (5% hydrochloric acid) may improve its response. Be sure to follow the CAUTION above and to rinse the sensor's tip thoroughly with tap water. If the sensor will not calibrate, it must be replaced.

**6.4 Cleaning Platinum Electrode.** The electrode is never exposed to these undesirable compounds. In the event poisoning is suspected, the electrode can be restored to normal operation by simply cleaning the platinum electrode with baking soda. Polish it by rubbing it with a damp paper towel and baking soda until a bright, shiny appearance is attained.

**6.5 Automatic Temperature Compensator.** The temperature compensator element is temperature sensitive and can be checked with an ohmmeter. Resistance increases with temperature.

The 3K element will read 3000 ohms ± 1% at 25°C (77°F) and a Pt-100 will read 110 ohms. Resistance varies with temperature for a 3K and Pt-100 element and can be determined according to Table 6-2 or the following formula:

$$R_T = R_0 [1 + R_1 (T - 20)]$$

Where  $R_T$  = Resistance

T = Temperature in °C

Refer to Table 6-1 for  $R_0$  and  $R_1$  values:

**TABLE 6-1**  
 **$R_0$  and  $R_1$  VALUES FOR TEMPERATURE**  
**COMPENSATION ELEMENTS**

Temperature Compensation Element	$R_0$	$R_1$
3K	2934	.0045
PT-100	107.7	.00385

**TABLE 6-2**  
**TEMPERATURE vs RESISTANCE OF AUTO**  
**T.C. ELEMENTS**

Temperature °C	Resistance (Ohms) ±1%	
	3K	PT-100
0	2670	100.0
10	2802	103.8
20	2934	107.7
25	3000	109.6
30	3066	111.5
40	3198	115.4
50	3330	119.2
60	3462	123.1
70	3594	126.9
80	3726	130.8
90	3858	134.6
100	3990	138.5

**6.6 Sensor Tube Replacement When Used With A Sensor Head Junction Box.** Replacement of the retraction versions sensor tube assembly involves the removal and installation of two sets of male connectors: One at the process end of the sensor, and the other at the junction box end (See Figures 6-1, 6-2). Refer to Section 6.2 for proper removal of the sensor from process.

1. Remove sensor from process before proceeding. The junction box with attached male connector must be recovered from the old sensor for reuse. Unscrew the junction box cover and set aside. Disconnect electrical connections from printed circuit board inside junction box. Disconnect BNC connector to preamp. Unscrew hex nut (D) from male connector body (C). Separate junction box from used sensor. Set aside.
2. Pry off split ferrule from sensor and set aside for reuse. Remove hex nut (D) and set aside for reuse. Check that the internal O-ring is in place in the male connector body (C) attached to the junction box.
3. Remove hex nut (B) from male connector body (A) at process end of sensor and set aside. Slide the Teflon ferrule and the male connector off sensor in the direction of junction box and set

**NOTE**

If stainless steel ferrule was used, male connector body (A) will have to be discarded with the sensor tube.

4. Discard used O-ring from male connector body (A). Coat new O-ring with a thin film of the O-ring lubricant provided. Position it in the machined O-ring groove in place of the discarded O-ring.

### CAUTION

Make sure lubricant does not contact any part of the sensor tip particularly the glass bulb.

5. Cover the 1" MNPT pipe threads of the male connector body (A) with Teflon tape (not provided) to protect them from galling during reinstallation.
6. Pass the wires from the new sensor through the process end male connector (A). Make sure that the beveled edge of the ferrule faces the process end of the sensor. Snug the hex nut (B) to keep it in place. Do not tighten down fully on the hex nut at this time.
7. Pass the wires from the new sensor through the hex nut (D), the split ferrule (from the old sensor), male connector body (C), O-ring, and through the junction box from the "neck" opening and out to the printed circuit board in the junction box. Butt the ferrule's beveled edge and the sensor tube against the junction male connector (C). Screw the hex nut (D) by hand until the tube is "locked" into the male connector body. Make sure that the male connector body (C) is sufficiently tightened. The sensor will "click" into place by pulling the sensor tube away from the junction box, but will not move from side to side or pull clear of the male connector. If the sensor tube is correctly attached to the junction box, wrench tighten hex nut (D) on male connector body (C) (see Figure 6-1). Do not put the sensor tube in a vise or use a pipe wrench to tighten the hardware as these will damage the sensor. If sensor tube is not correctly attached to the junction box, loosen hex nut (D) and repeat.
8. Connect the sensor wires to the terminals on the printed circuit board in the junction box in the manner recommended on the junction box cover, and reattach the BNC connector to the preamp. Screw on the cover of the junction box aside. Discard sensor tube.
9. Insert the sensor in the process fitting. Stop it against the closed ball valve. Slide the process-end male connector down the sensor tube to mate with the process fitting. Tighten the male connector into the process fitting.

10. Pull back hard on the sensor assembly, as if trying to remove the sensor, to be certain that the sensor cannot come free from the valve assembly and male connector. The built-in retraction stop collar at the end of the sensor will butt against the shoulder of the male connector.
11. Open ball valve and position the sensor at the desired insertion depth and orientation. Using a crescent or open end wrench, tighten the hex nut (B) to secure the sensor in place. See Figure 6-2.

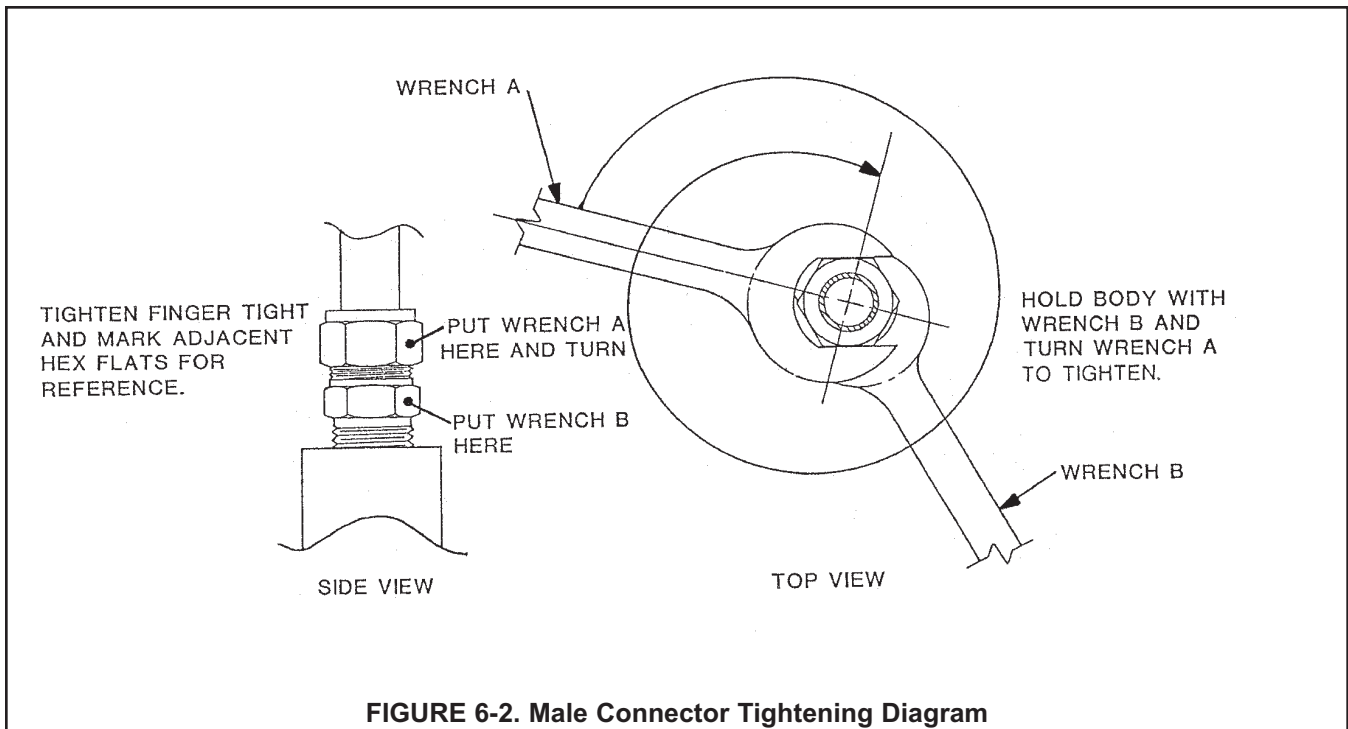
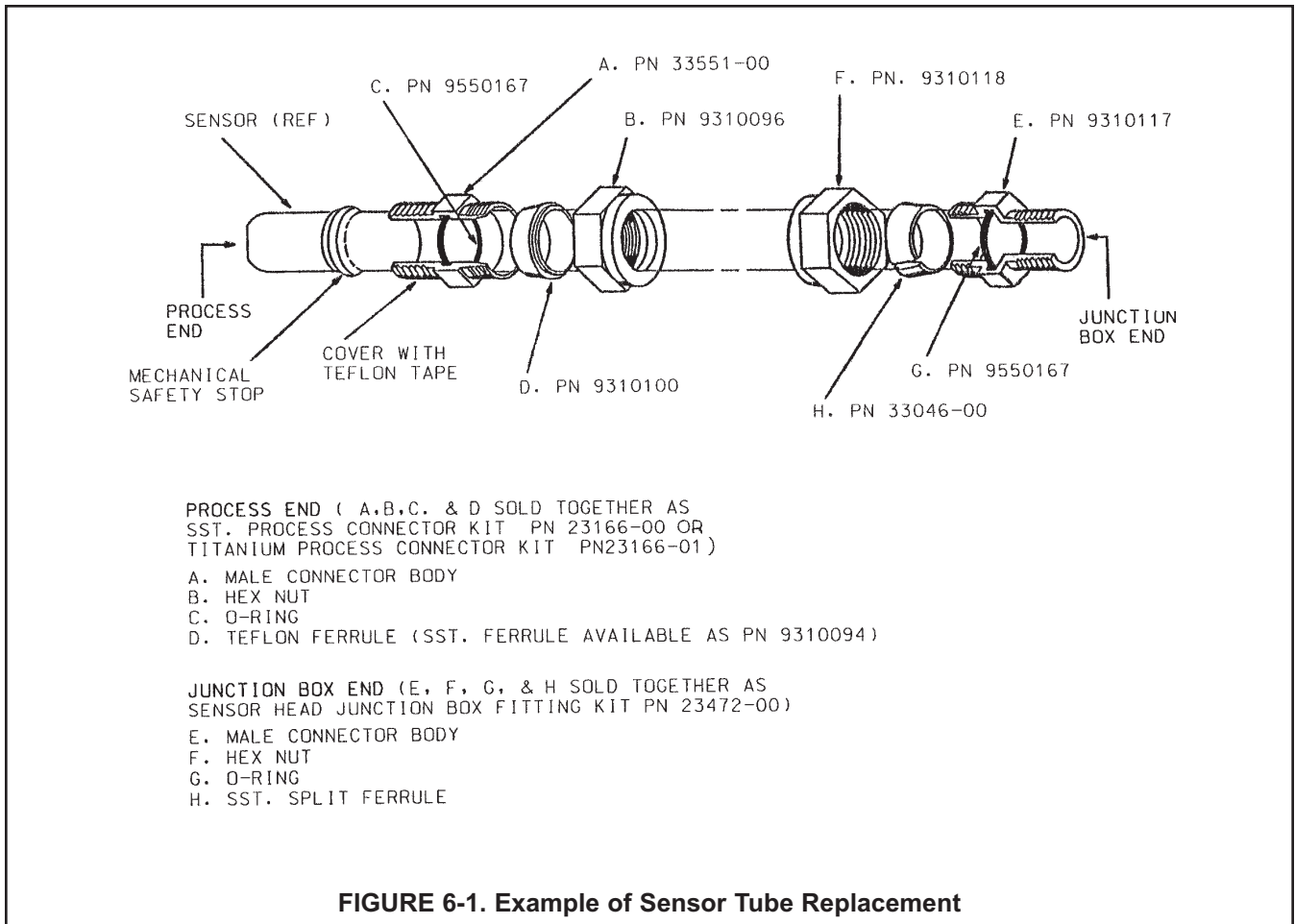
#### NOTE

A stainless steel ferrule is available if the Teflon ferrule does not adequately grip, be careful and avoid over tightening. This can damage the sensor tube.

### CAUTION

If the male connector leaks during insertion or retraction, replace the O-Ring (PN 9550099) in the male connector body (A).

If the sensor is to be stored, the rubber boot should be filled with 7pH buffer solution and replaced on sensor tip until ready to use.



## SECTION 7.0

# DIAGNOSTICS AND TROUBLESHOOTING

**7.1 DIAGNOSTICS AND TROUBLESHOOTING WITH MODEL 54/81/3081 pH/ORP.** The Model 54 and 54e Analyzers and Models 81 and 3081 pH Transmitters automatically search for fault conditions that would cause an error in the measured pH value, as does the Model 1054A/B pH/ORP Analyzer to a lesser degree. Refer to the respective manual for a complete description of the analyzer's fault conditions.

Table 7-1 lists the Analyzer/Transmitters diagnostic messages that indicate a possible sensor problem. A more complete description of the problem and a suggested remedy corresponding to each message is also listed.

**TABLE 7-1 Troubleshooting with Diagnostics**

<b>DIAGNOSTIC MESSAGE 54 and 54e 81/3081</b>	<b>DESCRIPTION OF PROBLEM</b>	<b>REMEDY</b>
"Calibration Warning" CALbrAtE	1. Aged glass. 2. Sensor not immersed.	1. Perform buffer calibration. 2. Be sure electrode measuring tip is in process.
"Cracked glass failure" bLASS FAIL	Broken or cracked glass.	Replace Sensor.
"High reference impeded" rEF FAIL or rEF WArn	1. Liquid junction coated. 2. Reference Cell gel depleted. 3. Sensor not immersed.	1. Clean sensor; replace if necessary. 2. Replace sensor. 3. Be sure electrode measuring tip is in process.
"Input voltage high" "Input voltage low"	pH input shorted or sensor miswired.	Check wiring. Replace sensor if necessary.
"Old glass warning" bLASS WArn	1. Glass electrode worn out. 2. Sensor not immersed.	1. Replace sensor. 2. Be sure electrode measuring tip is in process.
"Reference offset err" (offline only) Std Err	Reference electrode poisoned.	Replace sensor.
"Ref voltage high" "Ref voltage low"	1. Reference shorted or sensor miswired. 2. Sensor not immersed.	Check wiring. Replace sensor if necessary.
"Sensor line open" LiNE FAIL	1. Open wire between sensor and analyzer. 2. Interconnecting cable greater than 1000 ft.	1. Check sensor wiring. 2. Relocate analyzer.
"Sensor miswired"	1. Open wire between sensor and analyzer. 2. Bad preamplifier.	1. Check wiring. 2. Replace preamplifier.
"Temp error high" "Temp error low" tEMP HI tEMP LO	1. Open or shorted RTD. 2. Temperature out of range.	1. Replace sensor. 2. Check process temperature.



**7.2 TROUBLESHOOTING WITHOUT DIAGNOSTICS.** Table 7-2 lists common problems, causes and remedies typically encountered in process measurement.

**TABLE 7-2. Troubleshooting without Diagnostics**

<b>Problem</b>	<b>Probable Cause</b>	<b>Remedy</b>
Meter reads off scale. (Display reads overrange).	Defective preamplifier.	Replace preamplifier (for code 02 sensors). For code 01, replace sensor.
	T.C. element shorted.	Check T.C. element as instructed in Section 6.5 and replace sensor if defective.
	Sensor not in process or sample stream is low.	Make sure sensor is in process with sufficient sample stream (refer to Section 2.0 for installation details).
	Open glass electrode.	Replace sensor.
	Reference element open - no contact.	Replace sensor.
Display reads between 3 and 6 pH regardless of actual pH of solution or sample.	Electrode cracked.	Replace sensor.
Meter or display indication swings or jumps widely in AUTO T.C. Mode.	T.C. element shorted.	Check T.C. element as instructed in Section 6.5 and replace sensor if defective.
Span between buffers extremely short in AUTO T.C. Mode.	T.C. element open.	Check T.C. element as instructed in Section 6.5 and replace sensor if defective.
Sluggish or slow meter indication for real changes in pH level.	Electrode coated.	Clean sensor as instructed in Sections 6.3 or 6.4. Replace sensor if cracked.
	Electrode defective.	Replace sensor.
Transmitter cannot be standardized.	Electrode coated or cracked.	Clean Sensor as instructed in Sections 6.3 or 6.4 Replace sensor if cracked.
	Defective preamplifier.	Replace preamplifier.
Transmitter short spans between two different buffer values.	Aged glass electrode or high temperature exposure.	Replace sensor.
	Electrode coated .	Clean Sensor as instructed in Sections 6.3 or 6.4. Replace sensor if cracked.

## SECTION 8.0 RETURN OF MATERIAL

### 8.1 GENERAL.

To expedite the repair and return of instruments, please call 1-949-757-8500 for a Return Materials Authorization (RMA) number.

### 8.2 WARRANTY REPAIR.

The following is the procedure for returning instruments still under warranty:

1. Call Rosemount Analytical for authorization.
2. To verify warranty, supply the factory sales order number or the original purchase order number. In the case of individual parts or sub-assemblies, the serial number on the unit must be supplied.
3. Carefully package the materials and enclose your "Letter of Transmittal" (see Warranty). If possible, pack the materials in the same manner as they were received.
4. Send the package prepaid to:

Emerson Process Management  
Liquid Division  
2400 Barranca Parkway  
Irvine, CA 92606

Attn: Factory Repair

RMA No. \_\_\_\_\_

Mark the package: Returned for Repair

Model No. \_\_\_\_\_

### 8.3 NON-WARRANTY REPAIR.

The following is the procedure for returning for repair instruments that are no longer under warranty:

1. Call Rosemount Analytical for authorization.
2. Supply the purchase order number, and make sure to provide the name and telephone number of the individual to be contacted should additional information be needed.
3. Do Steps 3 and 4 of Section 8.2.

#### NOTE

Consult the factory for additional information regarding service or repair.

## WARRANTY

Seller warrants that the firmware will execute the programming instructions provided by Seller, and that the Goods manufactured or Services provided by Seller will be free from defects in materials or workmanship under normal use and care until the expiration of the applicable warranty period. Goods are warranted for twelve (12) months from the date of initial installation or eighteen (18) months from the date of shipment by Seller, whichever period expires first. **Consumables, such as glass electrodes, membranes, liquid junctions, electrolyte, o-rings, catalytic beads, etc., and Services are warranted for a period of 90 days from the date of shipment or provision.**

Products purchased by Seller from a third party for resale to Buyer ("Resale Products") shall carry only the warranty extended by the original manufacturer. Buyer agrees that Seller has no liability for Resale Products beyond making a reasonable commercial effort to arrange for procurement and shipping of the Resale Products.

If Buyer discovers any warranty defects and notifies Seller thereof in writing during the applicable warranty period, Seller shall, at its option, promptly correct any errors that are found by Seller in the firmware or Services, or repair or replace F.O.B. point of manufacture that portion of the Goods or firmware found by Seller to be defective, or refund the purchase price of the defective portion of the Goods/Services.

All replacements or repairs necessitated by inadequate maintenance, normal wear and usage, unsuitable power sources, unsuitable environmental conditions, accident, misuse, improper installation, modification, repair, storage or handling, or any other cause not the fault of Seller are not covered by this limited warranty, and shall be at Buyer's expense. Seller shall not be obligated to pay any costs or charges incurred by Buyer or any other party except as may be agreed upon in writing in advance by an authorized Seller representative. All costs of dismantling, reinstallation and freight and the time and expenses of Seller's personnel for site travel and diagnosis under this warranty clause shall be borne by Buyer unless accepted in writing by Seller.

Goods repaired and parts replaced during the warranty period shall be in warranty for the remainder of the original warranty period or ninety (90) days, whichever is longer. This limited warranty is the only warranty made by Seller and can be amended only in a writing signed by an authorized representative of Seller. Except as otherwise expressly provided in the Agreement, THERE ARE NO REPRESENTATIONS OR WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, AS TO MERCHANTABILITY, FITNESS FOR PARTICULAR PURPOSE, OR ANY OTHER MATTER WITH RESPECT TO ANY OF THE GOODS OR SERVICES.

## RETURN OF MATERIAL

Material returned for repair, whether in or out of warranty, should be shipped prepaid to:

**Emerson Process Management  
Liquid Division  
2400 Barranca Parkway  
Irvine, CA 92606**

The shipping container should be marked:

Return for Repair

Model \_\_\_\_\_

The returned material should be accompanied by a letter of transmittal which should include the following information (make a copy of the "Return of Materials Request" found on the last page of the Manual and provide the following thereon):

1. Location type of service, and length of time of service of the device.
2. Description of the faulty operation of the device and the circumstances of the failure.
3. Name and telephone number of the person to contact if there are questions about the returned material.
4. Statement as to whether warranty or non-warranty service is requested.
5. Complete shipping instructions for return of the material.

Adherence to these procedures will expedite handling of the returned material and will prevent unnecessary additional charges for inspection and testing to determine the problem with the device.

If the material is returned for out-of-warranty repairs, a purchase order for repairs should be enclosed.



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Fax: (949) 474-7250  
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